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AUTOMATION

nanoNavigator User Manual

UM SWD EN NLC-NAV01

Order No.: 2701441

Installing and using nanoNavigator™ software to configure nanoLine controllers

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This user manual is valid for:

Designation	Version	Order No.
nanoNavigator	2.0	2701221

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In order to ensure the safe use of the product described, you have to read and understand this manual. The following notes provide information on how to use this manual.

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DANGER
This indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
This indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
This indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

The following types of messages provide information about possible property damage and general information concerning proper operation and ease-of-use.

NOTE
This symbol and the accompanying text alerts the reader to a situation which may cause damage or malfunction to the device, either hardware or software, or surrounding property.

This symbol and the accompanying text provides additional information to the reader. It is also used as a reference to other sources of information (manuals, data sheets, literature) on the subject matter, product, etc.

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Section 1

This section provides information about:

- The contents of this manual
- Manual conventions
- Contacting Technical Support

Before Beginning 1-3

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1 Before Beginning

Welcome to the nanoNavigator™ software from Phoenix Contact — the software that makes the most of the nanoLine controller (nanoLC). nanoNavigator is the programming environment for the nanoLC.

1.1 About This User's Manual

This User Manual provides complete information on how to use nanoNavigator for the nanoLC.

1.1.1 What's Inside

This manual includes the following sections:

Section 1, "Before Beginning" provides an overview of nanoNavigator and this manual.

Section 2, "Getting Started" describes how to install and start nanoNavigator and connect to nanoLC.

Section 3, "Flow Chart Programming" describes how to create projects using the flow chart capabilities within nanoNavigator.

Section 4, "Ladder Chart Programming" describes how to create projects using the ladder chart capabilities within nanoNavigator.

Section 5, "Data Operations" defines the available data types in nanoNavigator and how to move data and use mathematical and relational expressions.

Section 6, "Running Projects and Controlling the nanoLC", describes how to run projects.

Section 7, "Verifying a Project", provides information on how to monitor and verify running projects.

Section 8, "Flow Chart Tutorial", describes how to install nanoNavigator, connect to nanoLC, create a flow chart project, and verify the project.

1.2 Revisions

Table 1-1 Revisions

Software version	Documentation	Description
1.2		Original release
1.3	B	Added analog input module. Required firmware update.
–	C	General edits and corrections
1.4	D	Added Simulator
2.0	E	Added Ladder Chart logic; General edits

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1.3 System Requirements

nanoNavigator requires:

- Keyboard and mouse
- Display (800x600 minimum resolution)
- Windows 2000 (SP4), Windows XP (SP2), or Windows Vista operating systems
- 400 MHz processor
- 128 MB memory
- Hard Drive — 280 MB required for .net framework 2.0 ;
  10 MB required for nanoNavigator and projects
- .net framework 2.0
- MDAC 2.8
- Windows installer 3.0 (required to install .net)
- IE6 SP1 (required to install .net)

1.4 Manual Conventions

This section discusses text conventions used throughout the manual.

Folder and File Names

Folder and file names appear in quotation marks. For example, “\nanoNavigator” is a folder name; “MyProject.nano” is a file name.

Titles, Buttons, Keywords, Mnemonics

Command buttons, keywords and phrases found in dialog boxes appear in quotes. For example, the text might say, ‘click the “Apply” button’ to indicate that there is a button in the dialog box labeled “Apply”. Menu selections also appear in quotes (for example, “File” menu), and submenu selections follow an ellipsis after the main menu (for example “File... Print” menu). In some cases, words and characters in a bold version of the text font indicate **emphasis**.

Other Text Conventions

There are a few hypertext links to Web pages. They appear as underlined text. (for example, www.phoenixcontact.com). When viewing this manual in Adobe Acrobat, they also appear as blue text. Clicking one of these links launches the Web browser and attempts to connect to the link.

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1.4.1 Keyboard Commands

Key names are shown as <Alt>, <Ctrl>, or <Home>. Keyboard commands, key combinations, and key sequences are shown in Table 1-2:

Table 1-2 Manual Conventions for Keyboard Command

Keystroke(s)	Description
<Key1>+<Key2>	A plus sign (+) between key names means to press and hold the first key (<Key1>) and type the second key (<Key2>). For example, <Alt>+<F4> means to hold down the <Alt> key, press the <F4> key, and then release both keys.
<Key1>, <Key2>	A comma (,) between key names means to type the keys individually in the sequence shown. For example, if instructed to type <R>, <Enter>, type the letter <R>, release it, and then press the <Enter> key.

1.4.2 Using a Mouse

nanoLine controller development with nanoNavigator requires use of a mouse. When using a mouse, make choices and selections using the standard left mouse button, unless it is a left-hand mouse or it has been remapped to use the right button. With the mouse pointer over an object, clicking the right mouse button (unless remapped) often displays a pop-up menu of commands that are available depending on the context (also called context or pop-up menus).

1.5 Phoenix Contact Technical Service

To obtain answers to questions about nanoNavigator that don't appear to be in this manual, contact Phoenix Contact Technical Service via the Internet. Our staff will provide advice needed to get the most from the nanoLC and nanoNavigator.

We suggest trying to duplicate the problem before contacting Technical Service. During this process, write down each step performed and any error messages that appeared.

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Section 2

This section provides information about:

– Installing and starting nanoNavigator
– Configuring a nanoLC within nanoNavigator
– Connecting nanoNavigator to the nanoLC

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2 Getting Started

This section provides help getting started with nanoNavigator software and nanoLine controller (nanoLC). The first step is to install nanoNavigator on a PC, and then connect to the nanoLC. To use the nanoLC, begin by creating a control program using nanoNavigator, and then transfer the program to the nanoLC.

nanoNavigator provides two methods to create program logic: flow chart or ladder charts. Flow charts use blocks and flow lines with the blocks representing actions and decisions, and the flow lines indicating direction of movement.

A tutorial on flow chart programming provides an overview of nanoNavigator features using a sample project (see Section 8, “Flow Chart Tutorial”). The tutorial includes building the project, and then monitoring and verifying it. To get the full benefit of the tutorial, you should have a nanoLC. If a nanoLC is not available, you can go through the building of the project, and then use the simulator to verify it.

Ladder charts use contacts and coils to represent the actions of the program. The contacts and coils are assembled into “rungs” like a ladder, with each rung representing a piece of logic that is either true or false, 1 or 0, or ON or OFF. The coils and contacts are similar to relays and is therefore sometimes referred to as relay ladder logic.

The option of using ladder charts to program the nanoLC is available with nanoNavigator 2.0 and later. Ladder charts use relays to express the programming logic.

Projects can use a mixture of flow charts and ladder charts. Since each programming method is actually “converted” to a language the nanoLine controller understands, it makes no difference which type of chart is used. Because different logic is used, charts cannot be converted between type.

NOTE:

Ladder charts cannot be opened with the Flow Chart Editor and flow charts cannot be opened with the Ladder Chart Editor.

2.1 Installing nanoNavigator

To install nanoNavigator, either download a copy from the www.phoenixcontact.com or use the CD that comes with a nanoLC Startup Kit. nanoNavigator is also available separately. With the installation CD or file download, follow these steps:

1. Start the installation program.
   - For a file download saved to disk, find the setup executable file and double-click it.
   - With an installation CD, insert it in the CD drive. It should automatically start. If it doesn’t, use Windows Explorer to navigate to the CD drive, go to the “nanoNav” folder, and double-click the setup executable file.

The name of the setup executable file varies. It will, however, always be an “.exe” file. For more specific instructions, see the readme instructions on the CD.

2. Follow the instructions of the installation wizard. The wizard has multiple pages. After completing each page, click the “Next” button at the bottom of the page.
3. Click the “Finish” button to complete installation.

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2.2 Starting nanoNavigator

After installation of nanoNavigator, the software can be started:

1. From the Windows “Start” menu, select “Programs... Phoenix Contact... nanoNavigator... nanoNavigator” to start the program.

Each time nanoNavigator starts, it displays the “nanoNavigator Startup” dialog box.

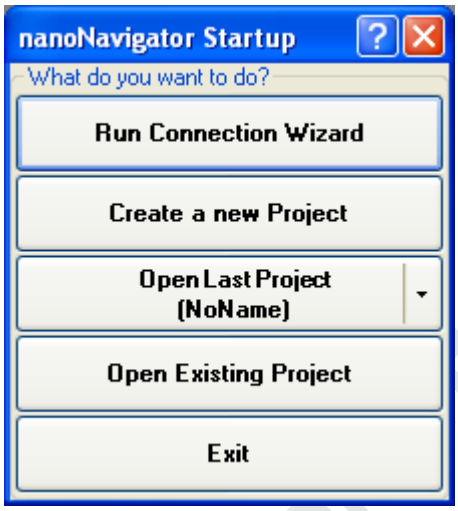

Figure 2-1 “nanoNavigator Startup” dialog box

2.2.1 Run Connection Wizard

The Run Connection Wizard requires a physical connection between the PC and a nanoLC. Click the “Run Connection Wizard” button and nanoNavigator communicates with the connected nanoLC and determines the status of the project stored in the nanoLC memory. This information is displayed and several options are made available.

Additional information on how to connect a nanoLine controller to a PC can be found in “Connecting to a nanoLC” on page 2-13.

To update the firmware in the nanoLC, click the “Run Connection Wizard” button and see “Updating nanoLC Firmware” on page 6-10.

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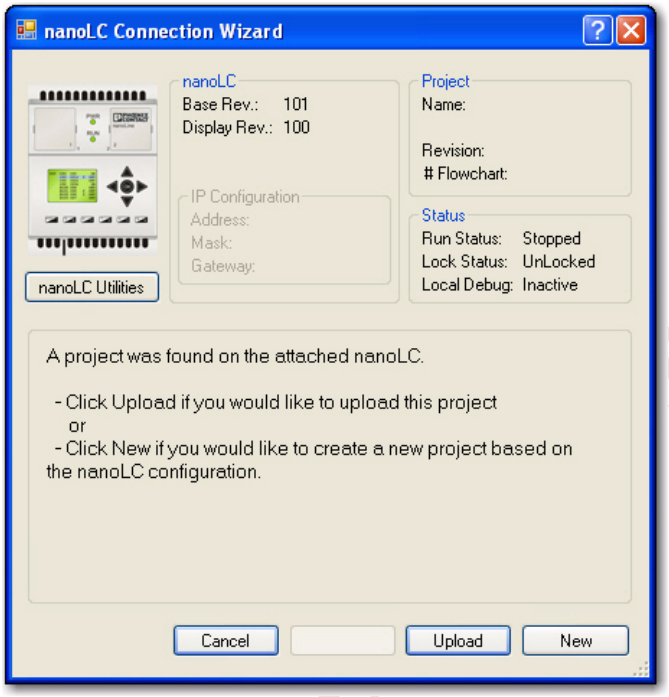

Figure 2-2 The "nanoLC Connection Wizard"

The operations available depend on the current state of the nanoLC.

– If there is a project loaded on the nanoLC, nanoNavigator displays a message indicating that a project exists and the “Upload” button is available. Click the “New” button to upload the project from the nanoLC to nanoNavigator.
– If there is no project on the nanoLC, nanoNavigator displays a message to that effect and the “Upload” button is gray. Click the “New” button and a new project is started using the configuration of the attached nanoLine controller. The “Select Type of First Chart” appears. Click either the “Create Flow Chart” button or the “Create Ladder Chart” button to create the desired type of chart.

The nanoLC operates in two modes:

– “Run mode” is the normal operating mode, and the mode required for connecting nanoNavigator to the nanoLC. In Run mode, a project on the nanoLC can be either running or stopped.
– “Monitor mode” permits monitoring operations directly on the nanoLC. When the nanoLC is in Monitor mode, nanoNavigator cannot connect to it.

For more information on directly monitoring on the nanoLC, see the “nanoLC Hardware User Manual.”

2.2.2 Create a New Project

Click the “Create a new Project” button and nanoNavigator displays the “Configuration” dialog box (see “Configuring nanoNavigator” on page 2-7). After configuration, a dialog box prompts to “Create Flow Chart” or “Create Ladder Chart” appears in the nanoNavigator workspace. Click the desired chart type and the appropriate chart editor opens.

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2.2.3 Open Last Project

The “Open Last Project” button displays the name of the most recently viewed project in parenthesis. Click the button to open the listed project and with the most recently viewed chart displayed.

To open a different project than the most recently viewed, click the drop-down menu to view the full path and file name of the most recently viewed projects. Click the desired file name to open the project.

2.2.4 Open Existing Project

Click the “Open Existing Project” button to display a browse dialog box opened to the directory most recently used to save or open a nanoNavigator project. The “Files of type” field is set to display all “.Nano” files in that directory.

nanoNavigator saves all project data, charts, and data items in one “.nano” file per project.

After nanoNavigator is open, the “Open Project” button in the Main toolbar and the “File... Open Project” menu perform the same operation. If there is a project currently open with any unsaved modifications, nanoNavigator displays a prompt requesting permission to save the changes before opening the new project.

2.2.5 Exit

Click the “Exit” button to exit nanoNavigator.

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2.3 Configuring nanoNavigator

If a nanoLC is connected to the PC, nanoNavigator can automatically set up the nanoLC configuration by doing one of the following:

– When nanoNavigator first starts, click the “Run Connection Wizard” button in the “nanoNavigator Startup” dialog box (see Figure 2-1).
– At any time, select the “nanoLC... Connect” menu.

If a nanoLC is not connected to the PC, select the “nanoLC... Configuration” menu to display the “nanoLC Configuration” dialog box (this dialog box also displays when creating a new project). It allows the programmer to define the target nanoLC on which the project will execute.

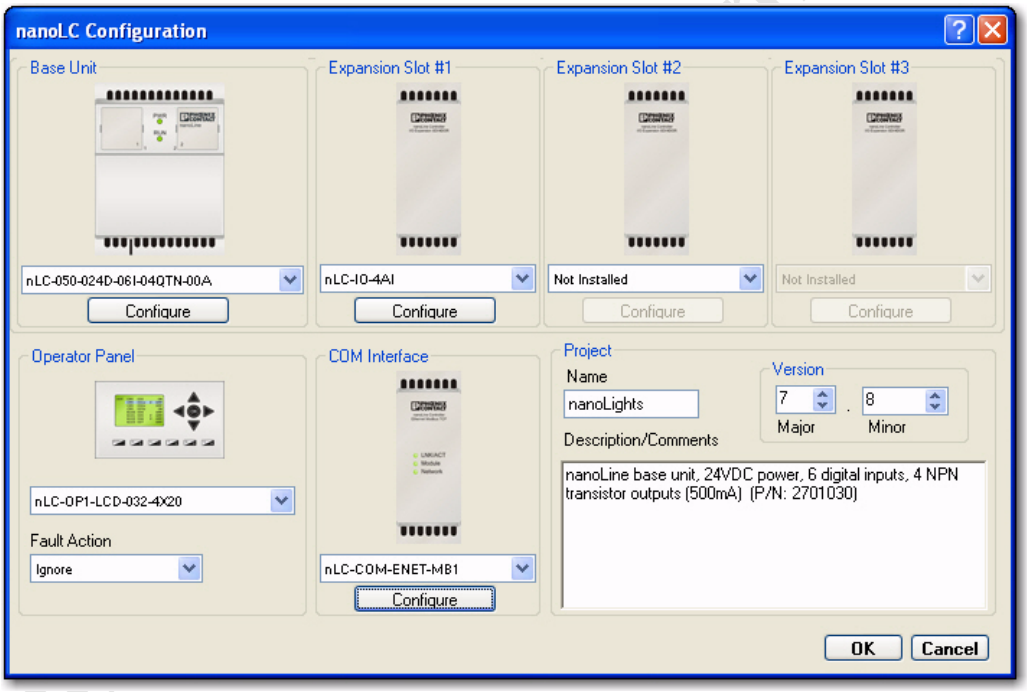

Figure 2-3 “nanoLC Configuration” dialog box

The options available in this dialog box define the target nanoLC. They are discussed in the following sections.

2.3.1 Base Unit

The “Base Unit” group selects a specific nanoLC base unit to use as the target for the project.

– From the “Base Unit” drop-down list, select the model number of the base unit. After selecting the base unit, the “Configure” button becomes available.

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– Click the “Configure” button to display the options available for the selected base unit.

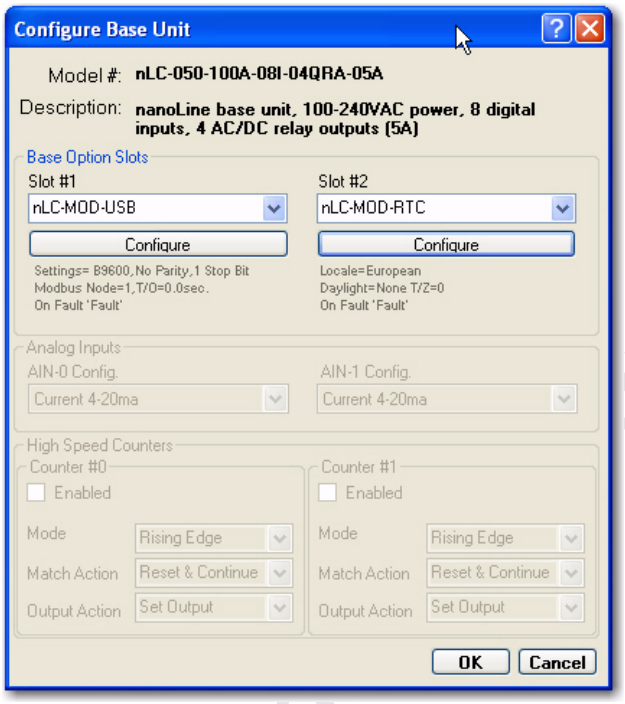

Figure 2-4 “Configure Base Unit” dialog box

Only options available on the base unit are available in this dialog box. For example, if the base unit does not support analog inputs, the two analog input drop-down lists are gray.

The “Configure Base Unit” dialog box displays the model number and description of the selected base unit. From the “Slot #1” or “Slot #2” drop-down list, click the option module that is installed in the slot. The current configuration of the selected option module is displayed, and the “Configure” button becomes available, if applicable.

When an option module is not installed, select “Not Installed” from the drop-down list.

Slot #1 RS-232, RS-485, USB Option Modules

Click the “Configure” button to configure the option module for Modbus RTU communication. The RS-232, RS-485, and USB options use the same “Configure Serial Port” dialog box (Figure 2-5).

Communication with a PC running nanoNavigator is set automatically by the software and is not manually configurable.

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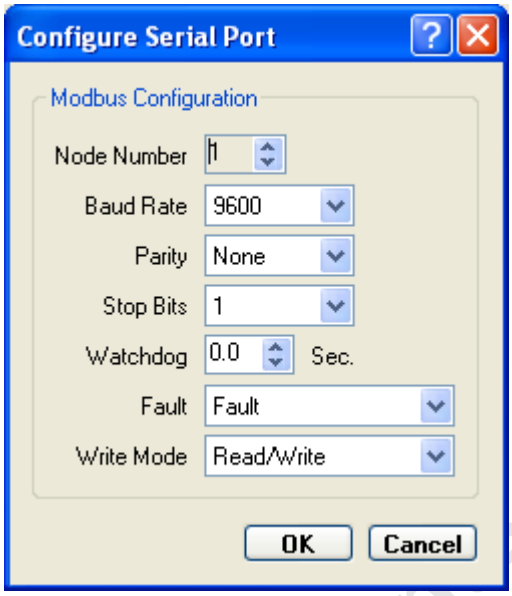

Figure 2-5 The “Configure Serial Port” dialog box

The “Configure Serial Port” dialog box has the following parameters:

- “Node Number” selects the node number for the serial port. Valid values are from 1 to 247.
- “Baud Rate” selects the baud rate from the drop-down list. Valid values are from 300 to 115200.
- “Parity” selects the data parity from the drop-down list. Valid values are “None”, “Odd”, and “Even”.
- “Watchdog” permits entry of a value, or use the spin buttons, to set the watchdog timer. Valid values are from 0.0 to 25.5 seconds. A value of 0.0 disables the watchdog timer. If no Modbus communication occurs before the Watchdog timer value is exceeded, a fault is generated by the nanoLC. The result of the fault is defined in the “Fault” drop-down list.
- The “Fault” field defines the result of a Modbus communication error. Available options are:
  - Select “Fault” to stop execution of the nanoLC. All outputs are turned OFF.
  - Select “Warning” to indicate warning condition and continue execution.
- “Write Mode” defines Modbus RTU Read/Write conditions.
  - Read/Write allows a Modbus Client to read and write commands to the nanoLC.
  - Read allows a Modbus Client to read data from the nanoLC.

When the dialog box is closed, the options selected are displayed in the “Configure Base Unit” dialog box in the “Base Option Slots” group (see Figure 2-4).

Slot #1 Memory Module

Select NLC-MOD-MEM 032K if using the optional memory module. See Section 6.6, “Downloading to the Memory Module” and Section 6.7, “Uploading from the Memory Module” for more information.

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Slot #2 Real-Time Clock

The real-time clock option is available in the “Slot #2” drop-down list. Selecting this option displays the “Configure RTC” dialog box (Figure 2-6).

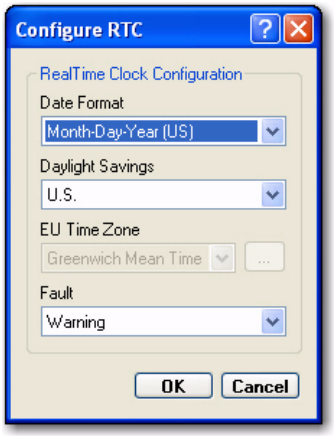

Figure 2-6 The “Configure RTC” dialog box

The “Configure RTC” dialog box has the following parameters:

- “Date Format” defines the date format using the drop-down list. Choices are Day-Month-Year (European), Month-Day-Year (US), and Year-Month-Day (International).
- “Daylight Savings” used to select one of three options for handling Daylight Savings time. Available options are:
  - “None”
  - “U.S.”
  - “European” (selecting this option enables the “EU Time Zone” fields)
- “EU Time Zone” has drop-down to select “Greenwich Mean Time”, “GMT +01:00”, and “GMT +02:00”. In addition, there is a browse (...) button that displays a selection dialog to set the EU time zone based on sample cities in the zone.
- “Fault” provides choices for handling faults are:
  - “Fault” sets a fault condition and stop execution.
  - “Warning” sets a warning condition and continue execution.

2.3.2 I/O Expansion Module #1... #3

The nanoLC supports up to three I/O Expansion Modules. Use the drop-down list to select the model of the module installed. Depending on the device selected, the “Configure” button may become available. When available, click the “Configure” button to define additional parameters in a configuration dialog box.

Configure I/O Expansion modules from left to right. The module installed closest to the base unit is #1. I/O Expansion module #1 must be configured before #2, and #2 must be configured before #3.

When modifying the configuration to add or delete I/O, nanoNavigator displays a warning message and the change takes effect immediately. There is no undo or cancel operation. The only way to undo this type of configuration change is to close the project without saving it.

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Configuring Analog Inputs

One of the I/O Expansion choices is “nLC-IO-4AI”. This expansion module provides four analog input devices. When selected, the “Configure” button is active. Clicking the “Configure” button displays the “nLC-IO-4AI” dialog box (see Figure 2-7) that configures the four analog inputs on this device.

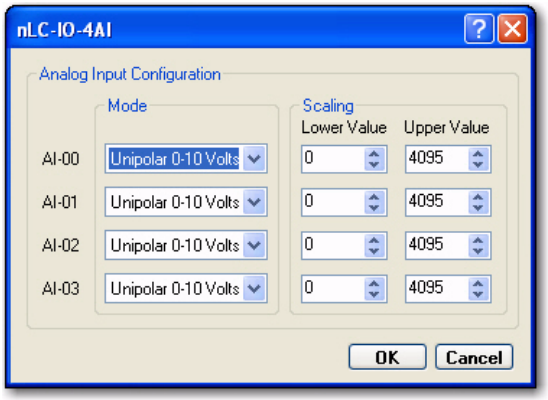

Figure 2-7 The “nLC-IO-4AI” configuration dialog box

Each analog input device (AI-00 to AI-03) has three parameters:

– “Mode” is a drop-down that provides the following choices:
  – Current 4-20 mA
  – Current 0-20 mA
  – Unipolar 0-10 Volts (default)
  – Bipolar +/-10 Volts
– “Scaling” has two configurable values for “Lower Value” and “Upper Value”. The range of values for each of these scaling parameters is from -10000 to 10000. Scaling is a technique for converting input voltages (or amperage) to an integer value (see “Handling Analog Values” on page 5-16).

2.3.3 Operator Panel

Use the drop-down list to select the model of Operator Panel installed.

Configure the “Fault Action” for the Operator Panel using the drop-down list. A fault occurs when the project expects an Operator Panel and the nanoLC doesn’t have one. Choices for handling faults are:

– “Fault” sets a fault condition and stop execution
– “Warning” sets a warning condition and continue execution
– “Warning on Access” sets a warning condition only if the project attempts to access the device and continue execution
– “Ignore” continues execution without posting a warning or fault condition

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2.3.4 COM Interface

Use the drop-down list to select the model of module installed. Once selected, the "Configure" button becomes available. For the "nLC-COM-ENET-MB1" option, click the "Configure" button to display the "Configure Ethernet" dialog box.

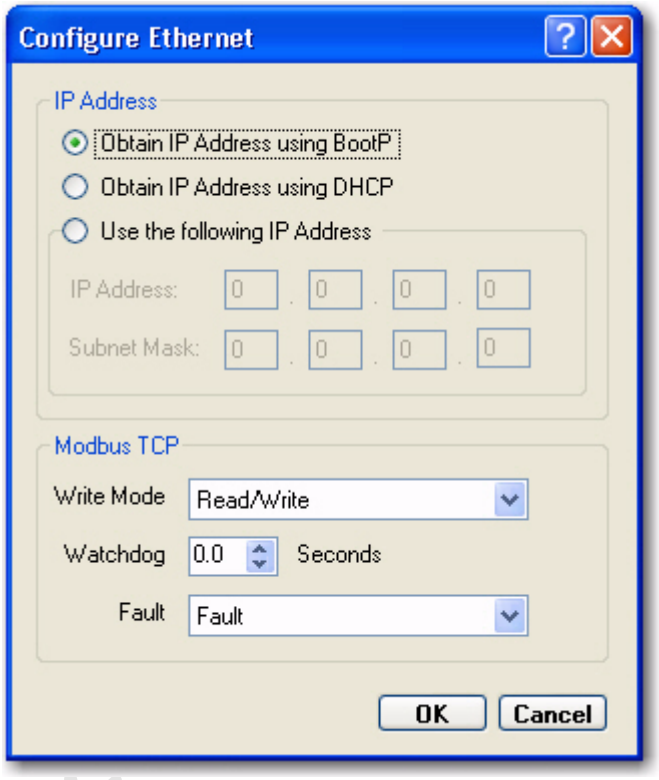

Figure 2-8 The "Configure Ethernet" dialog box configures the Ethernet option

The options available in this dialog box are:

- Click the "Obtain IP Address Using BootP" button to use an address assigned by Phoenix Contact "IPassign.exe" (downloadable from www.phoenixcontact.com), Factory Manager, or another BOOTP server.
- Click the "Obtain IP Address using DHCP" button if there is a DHCP server on the network.
- Click the "Use the following IP Address" button and enter the static "IP Address" and "Subnet Mask" in the fields that become available.
- Modbus TCP parameters and options are:
- "Write Mode" defines Modbus TCP Read/Write conditions.
  - Read/Write allows a Modbus Client to read and write commands to the nanoLC.
  - Read allows a Modbus Client to read data from the nanoLC.
  - The "Watchdog Timeout" field: enter a timeout value in the field or use the up/down buttons to set a value in seconds and tenths of a second. If the timeout is exceeded after executing a command, the nanoLC issues a fault as defined in the "Fault" field. Leave the Timeout value at "0.0" to disable the watchdog timer.

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– The “Fault” field: Provides options for handling a fault when the project is expecting a response from Modbus TCP and doesn’t receive one within the watchdog timeout limit. Choices for handling faults are: “Fault” sets a fault condition and stops execution, and “Warning” sets a warning condition and continues execution.

Project

In the Project group, change the project name and enter project comments. This group also includes “Major Version” and “Minor Version” options.

nanoLC Runtime the major and minor version numbers in the nanoLC to compare the project on the nanoLC with the project on the PC. The “Minor” version number automatically increments whenever the project downloads or is verified. It also increments on the nanoLC whenever a change is made (locally or by download). The “Major” version number indicates significant changes to the project. It only changes under user control; however, whenever the “Major” number changes, the “Minor” number resets to zero.

After selecting appropriate options, click the “OK” button to close the dialog box. Some of the options determine data items available in the Data Item Editor (see “Using the Data Item Editor” on page 5-3), and other nanoNavigator behavior.

2.4 Connecting to a nanoLC

There are two aspects to connecting to a nanoLC. The first is the physical connection between the PC running nanoNavigator and the nanoLC. This physical connection is either a serial or USB cable. The second aspect of connecting to a nanoLC is a logical connection via the cable. This logical connection lets nanoNavigator access the nanoLC. When using nanoNavigator to perform operations on the nanoLC, connect nanoNavigator to the nanoLC. Other than “Physical Connection” on page 2-14, all references to “connecting to the nanoLC” are regarding the logical connection between the nanoLC and nanoNavigator.

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2.4.1 Physical Connection

The nanoLC is connected to a PC (or other device) through an option module inserted in Slot 1 on the base unit. The option module connects via a USB, RS-232 or RS-422/485 cable.

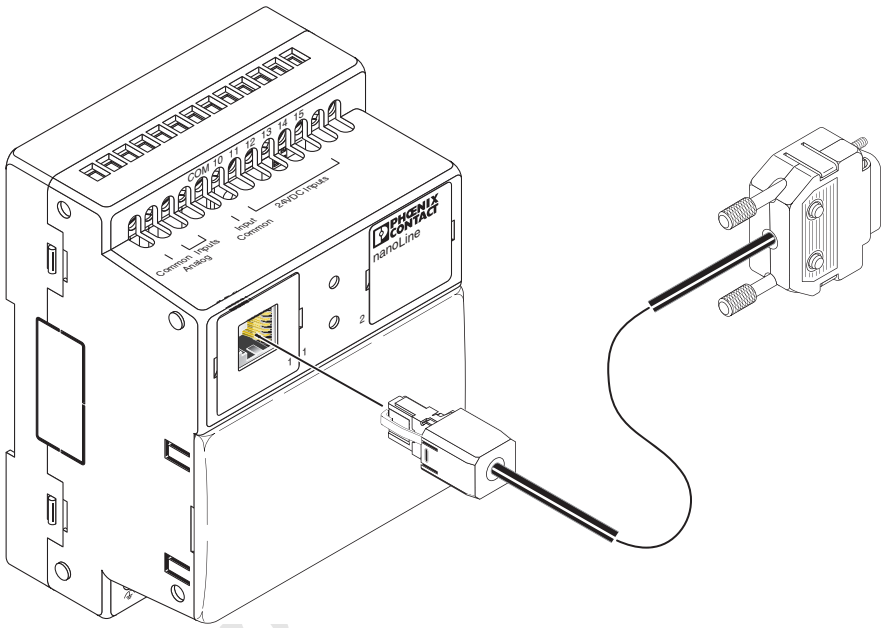

Figure 2-9 nanoLC RS-232 programming connection

For more information on making a physical connection between the nanoLC and a PC, see the “nanoLC Hardware User Manual.”

When using a USB port and cable to connect a PC to the nanoLC, a COM port is assigned to the nanoLC. Occasionally, this virtual COM port interferes with a physical COM port and must be re-assigned.

For more information on changing the COM port address assigned to a nanoLine controller, see the USB to COM Port Configuration Application Note (document 2706).

2.4.2 Connecting nanoNavigator to the nanoLC

Before transferring a project to or from the nanoLC, starting or stopping the project, monitoring it, or performing any other operations on the nanoLC, nanoNavigator must connect to the nanoLC. To perform a software connection from nanoNavigator to the nanoLC, the PC must be physically connected to the controller.

– If nanoNavigator is started, the “nanoNavigator Startup” dialog box appears. Click the “Run Connection Wizard” button and nanoNavigator communicates with the nanoLC.
– If nanoNavigator is running, select the “nanoLC…Download” or “nanoLC…Download & Go” menu. Or select the “nanoLC…Monitoring” menu to monitor the project as it runs on the nanoLine controller (see Section 6, “Running Projects and Controlling the nanoLC” for more information).

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Section 3

This section provides information about:

- Managing charts using Chart Explorer
- Using the Flow Chart Editor and creating flow charts
- Using the Message Editor

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3 Flow Chart Programming

When a new project is created, the user must choose to create either a flow chart or ladder chart (see Section 4, “Ladder Chart Programming”). A flow chart is a type of diagram that uses symbols to illustrate a control process. The symbols in the flow chart depict two classes of items: action blocks and branching blocks. For a detailed discussion of action and branching blocks, see “Flow Charting Primer” on page 8-3.

3.1 Exploring Flow Charts

When a new flow chart is created, nanoNavigator opens the current flow chart maximized in the Flow Chart Editor window.

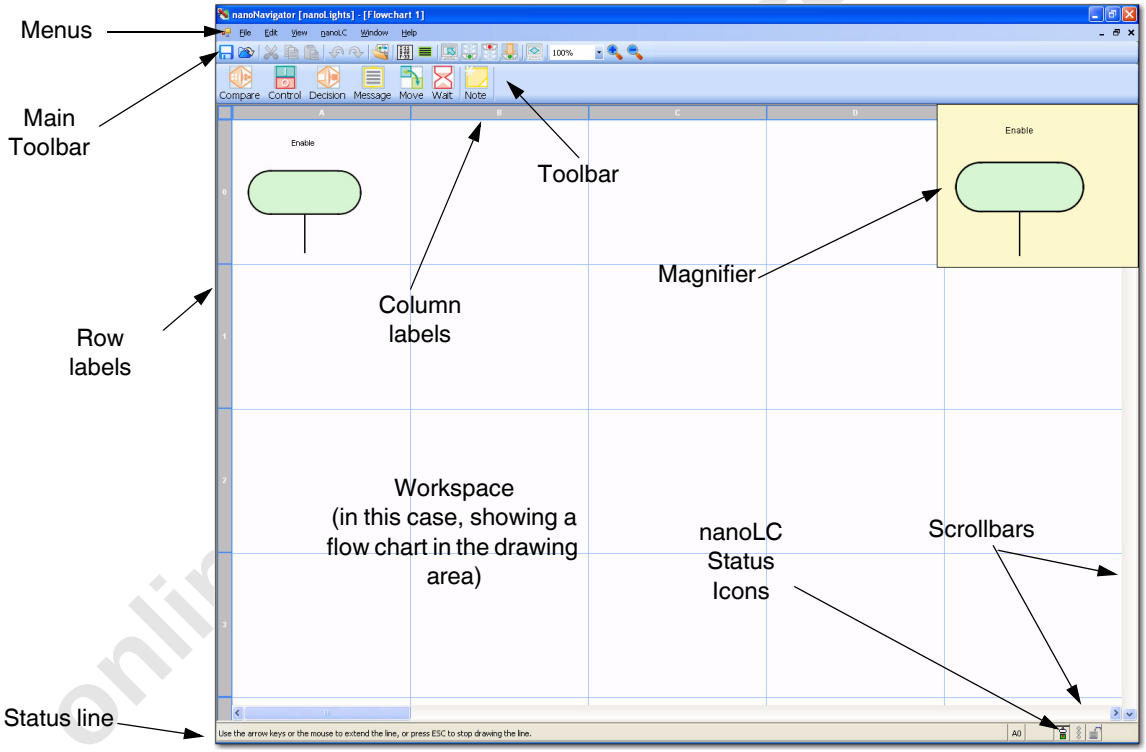

Figure 3-1 nanoNavigator showing a flow chart window

The key elements of the Flow Chart Editor window, shown in Figure 3-1, are:

– Menus: Provide access to all the commands in nanoNavigator, as well as online help.
– Toolbar: Contains toolbar buttons for placing blocks onto flow charts. With the “View... Auto-hide Toolbar” menu selected (the default), the Toolbar only appears with the Flow Chart Editor visible. With this menu unselected, the Toolbar also appears in the Data Item Editor and Message Editor, but it is only active in the Flow Chart Editor.
– Main Toolbar: Contains toolbar buttons for cut, copy, and paste. It also contains buttons to quickly access selections from the “View” and “nanoLC” menus (see “Using the Main Toolbar” on page 3-4).

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- Column labels: Provide a guide for locating shapes in the drawing area. nanoNavigator provides five columns for flow chart blocks.
- Row labels: Provide a guide for locating shapes in the drawing area. nanoNavigator provides an unlimited number of rows as they are needed... limited only by available memory.
- Drawing area: Build flow charts in the drawing area. Horizontal and vertical grid lines appear by default. Blocks must appear within a grid cell with only one block per cell.
- Magnifier: Appears when hovering the mouse pointer over a populated cell in the flow chart. Provides a more readable version of the cell's contents and labels. Toggle this feature ON (check mark present) or OFF using the "View... Magnifier" menu. By default, the Magnifier is ON.
- Scrollbars: Use the scroll bars to bring portions of the drawing area that are off-screen into view. To scroll in small increments, click the arrows at the end of each scroll bar.
- Status line: Provides information about nanoNavigator or selected shapes. Status elements include a Message area and nanoLC status icons. nanoLC status icon area presents three icons (from left to right) that reflect the state of the nanoLC. The icons are:
  - Connection state: Connected or not
  - Running state: Unknown (not connected); Running; Stopped
  - Locked state: Unknown (not connected); Locked; Unlocked

Connection State Icon (connected) | Running State Icon (running) | Locked State Icon (unlocked)

Figure 3-2 nanoLC status icons

3.1.1 Using the Main Toolbar

The Main toolbar (see Figure 3-3) is visible by default. To toggle the toolbar on and off, select the "View... Main Toolbar" menu.

Figure 3-3 Main toolbar

From left to right, the buttons in the toolbar are:

1. Save Project: Performs the same function as the "File... Save Project" menu.
2. Open Project: Performs the same function as the "File... Open Project" menu (see "Open Existing Project" on page 2-6).
3. Cut: Performs the same function as the "Edit... Cut" menu (see "Cut-Copy-Paste" on page 3-12).
4. Copy: Performs the same function as the "Edit... Copy" menu (see "Cut-Copy-Paste" on page 3-12).
5. Paste: Performs the same function as the "Edit... Paste" menu (see "Cut-Copy-Paste" on page 3-12).

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6. UnDo: Performs the same function as the “Edit... UnDo” menu (see “UnDo and ReDo” on page 3-12).
7. ReDo: Performs the same function as the “Edit... ReDo” menu (see “UnDo and ReDo” on page 3-12).
8. Chart Explorer: Opens the Chart Explorer (see “Chart Explorer” on page 3-6).
9. Edit Data Items: Opens the Data Item Editor (see “Using the Data Item Editor” on page 5-3).
10. Edit Messages: Opens the Message Editor (see “Using the Message Editor” on page 3-31).
11. Start Monitoring/Stop Monitoring: Toggles depending on whether or not nanoNavigator is currently monitoring the connected nanoLC. Performs the same function as the “nanoLC... Start Monitoring” menu and the “nanoLC... Stop Monitoring” menu (see “nanoLC Monitor Window” on page 7-4).
12. Run: Starts the current project running on the nanoLC. Performs the same function as the “nanoLC... Run” menu (see “Running a Project” on page 6-7).
13. Stop: Stops the current project on the nanoLC. Performs the same function as the “nanoLC... Stop” (see “Stopping a Running Project” on page 6-7).
14. Download & Go: Downloads the project currently open in nanoNavigator to the nanoLC. This single click saves, verifies, and then downloads the project to the nanoLC. It then runs the project on the nanoLC. Performs the same function as “nanoLC... Download & Go” menu (see “Downloading a Project” on page 6-5).
15. Simulator: Starts simulation of the project (see “Connecting to the Simulator” on page 8-39).
16. Zoom Buttons: Combo Box, Zoom In and Zoom Out (see “Zooming In or Out” on page 3-6).

3.1.2 Grid and Cell Address

The Flow Chart Editor uses a fixed grid of five columns (labeled “A” to “E”) by any number of rows (numbered “1” to n) for placement of flow chart blocks. The grid defines cells that are labeled by column letter and row number. For example, cell “A0” is the cell in the upper-left location of the flow chart. By default, the grid lines are visible in flow charts. Whether the grid lines are visible or not, cell references are by their cell address.

Turning the Grid On and Off

To turn the page grid on or off, follow these steps:

1. Select the “File... Preferences...” menu to display the multi-page Preferences dialog box.
2. Click the “Designer Options” tab.
3. Click the “Show Grid Lines” check box to turn the grid line on or off, respectively.
4. Click the “OK” button, and then answer any message dialog boxes that appear.

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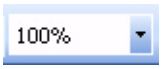
3.1.3 Zooming In or Out

Zoom Out (left) and In (right) toolbar buttons

The full design of a chart may be large and any page may be larger than the viewable Flow Chart Editor window. The following techniques show more of the page by setting the zoom factor:

- Select the desired zoom percentage from the “View... Zoom Factor...” menu.
- Click the “Zoom In” or “Zoom Out” tools in the Standard toolbar.
- Hold the <Ctrl> key and spin the middle mouse wheel (up to zoom in and down to zoom out).
- Hold the <Ctrl> key and press the main keyboard minus key to zoom out or the plus key to zoom in.
- Use the “Zoom” drop-down list in the Main toolbar.



Zoom drop-down list

3.2 Chart Explorer

A project can have up to 16 charts, in any combination of ladder and flow, with a total of approximately 500 blocks. Use multiple charts for all but the simplest projects with each chart controlling a single process, machine, or major function. A modular approach to developing chart programs makes it easier to create, verify, and maintain control projects.

Use the Verify Project (see Section “nanoLC Monitor Window” on page 7-4) to ensure the project is properly configured and does not exceed the capability of the hardware.

Once downloaded to a nanoLC, all enabled charts (flow or ladder) execute in the order they appear in the Chart Explorer. The project can programmatically control which charts execute during any given scan cycle. For more information on enabling charts, see “Enable Block” on page 3-13.

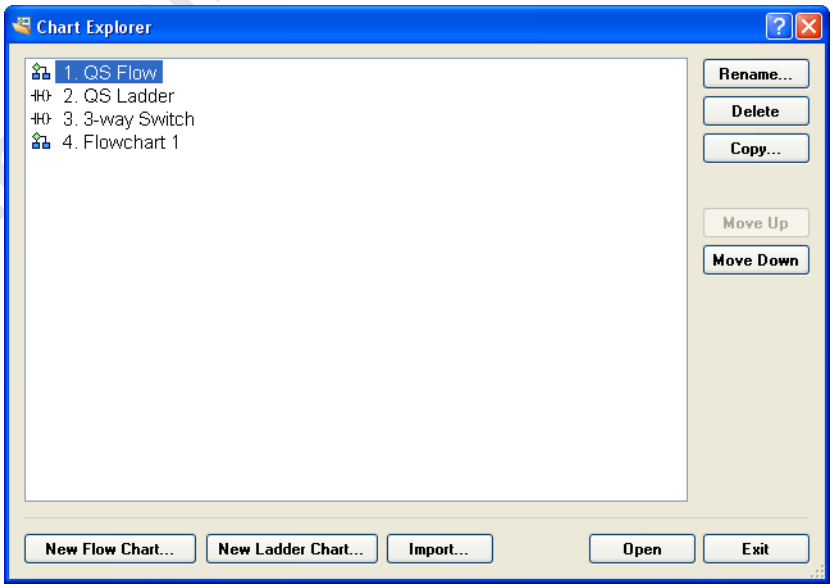


Figure 3-4 Chart Explorer

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Chart Explorer Button

To open the Chart Explorer and display a list of the charts (flow and ladder) in the project:

– Click the “Chart Explorer” button on the Main toolbar.
– Select the “View... Chart Explorer” menu.

An icon indicates the type of chart. Using the Chart Explorer automatically selects the correct chart editor (flow or ladder).

Flow charts cannot be opened using the Ladder Chart Editor and ladder charts cannot be opened using the Flow Chart Editor.

Flow charts appear in a Flow Chart Editor window. If the project consists of only one chart, nanoNavigator always displays it when the program starts.

If there are multiple charts in the project, nanoNavigator displays the last chart that was open when the program starts. If no chart window was open the last time the project closed, nanoNavigator displays the Chart Explorer to allow selection of a chart to open.

– Click the “Exit” button to close the Chart Explorer.

Alternatively, select the “File… New Chart” and choose either a flow or ladder chart from the list. To open an existing chart select the “File…Open Chart…” menu and click the desired chart from the list.

3.2.1 Opening a Flow Chart

To open a flow chart, for editing from the Chart Explorer, double-click the chart in the list or click the chart name to select it, and then click the “Open” button.

Alternatively, the ladder chart can be selected from the “File... Open Chart...” menu.

3.2.2 Creating a New Flow Chart

To create a new chart from the Chart Explorer, click the “New” button. The new chart will be the same type of chart as last viewed, either ladder or flow. To create a new chart of a different type, click the “New” button drop-down list on and click desired chart type.

Alternatively, select the “File… New Chart” and choose either a flow or ladder chart from the list.

3.2.3 Renaming a Flow Chart

To rename a chart, follow these steps:

1. Click the chart to highlight it, and then click the “Rename” button. Alternatively, right-click the desired chart, and then click “Rename” from the pop-up menu.
2. In the “Rename Chart” dialog box that appears, type the new name. Chart names are limited to 12 characters.
3. Click the “OK” button.

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3.2.4 Copying a Flow Chart

To copy a chart from the Chart Explorer, follow these steps:

1. Click the chart to highlight it, and then click the “Copy” button. Alternatively, right-click the desired chart, and then click “Copy” from the pop-up menu.
2. In the “Chart Name” dialog box that appears, leave the default new name or type the new name.
3. Click the “OK” button.

Alternatively, from the Flow Chart Editor, select the “File... Save Flow Chart As” menu to save the chart with a new name and include it in the project. The old chart remains open and in the project.

3.2.5 Changing Execution Order

The Chart Explorer provides the capability to rearrange chart execution order. To change chart execution order, do the following:

1. From the Chart Explorer, click the name of the desired chart to move.
2. Use the “Up” and “Down” buttons at the bottom of the window to reposition the highlighted chart.

Charts will execute in the order they are arranged. It doesn’t matter if it is a flow chart or ladder chart.

3.2.6 Import Charts

To import charts from another project, follow these steps:

3. Click the “Import” button to display the “Import Logic Chart” dialog box.

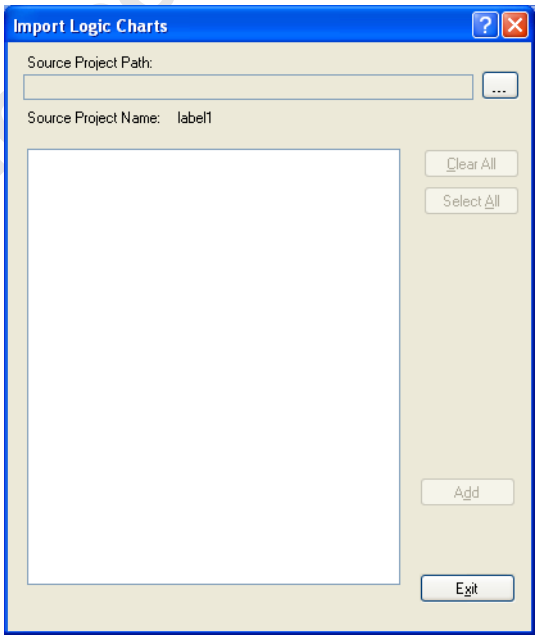

Figure 3-5 The “Import Logic Chart” dialog box

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4. Specify the source project by either typing the full path in the “Source Project Path” field or by clicking the “…” (browse) button.
5. Use the browse dialog box to navigate to the project directory and locate the source project (*.Nano” extension) that contains the charts to import. Once selected, the source project name appears in the “Import Logic Charts” dialog box and all charts in the project appear in the list.

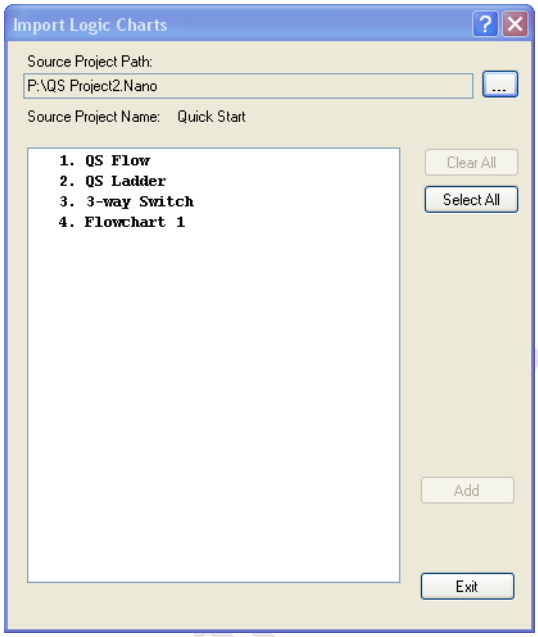

Figure 3-6 The “Import Logic Chart” dialog box with a project selected

6. Select one or more charts in the list using any of the following techniques:
   – Click on a chart.
   – Use standard Windows multiple selection techniques to select multiple charts.
   – Use the “Select All” button to select all charts in the project, and use the “Clear All” button to start over.
7. Click the “Add” button to add the selected charts to the current project.
8. Click the “Exit” button to close the “Import Logic Charts” dialog box.

3.2.7 Deleting a Flow Chart

To delete a flow chart use the Chart Explorer.

1. Click the chart to highlight it, and then click the “Delete” button or press the <Delete> key. Alternatively, right-click the desired chart, and then click “Delete” from the pop-up menu.
2. Click the “Yes” button in the confirmation box to delete the file or click the “No” button to cancel.

The only way to undo deletion of a chart is by closing the project without saving changes. This abandons all changes that were made to the project since the last save.

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3.3 Displaying Multiple Flow Charts

By default, when opening a chart, nanoNavigator maximizes it in the workspace. Switch to other open charts using either the list in the “Window” menu, or by pressing the <Ctrl>+<F6> or <Ctrl>+<Tab> (<Ctrl>+<Shift>+<F6> or <Ctrl>+<Shift>+<Tab> to reverse the order) keys. nanoNavigator also permits maximizing, minimizing, or closing any chart window by using the Window controls in the upper-right corner.

nanoNavigator allows multiple charts to be open simultaneously. This is very useful for copying flow chart logic from one flow chart to another.

NOTE:

Different chart types can be opened simultaneously. However, it is not possible to copy content between different chart types. Only content from a flow chart can be copied into a flow chart and only content from a ladder chart can be copied into a ladder chart.

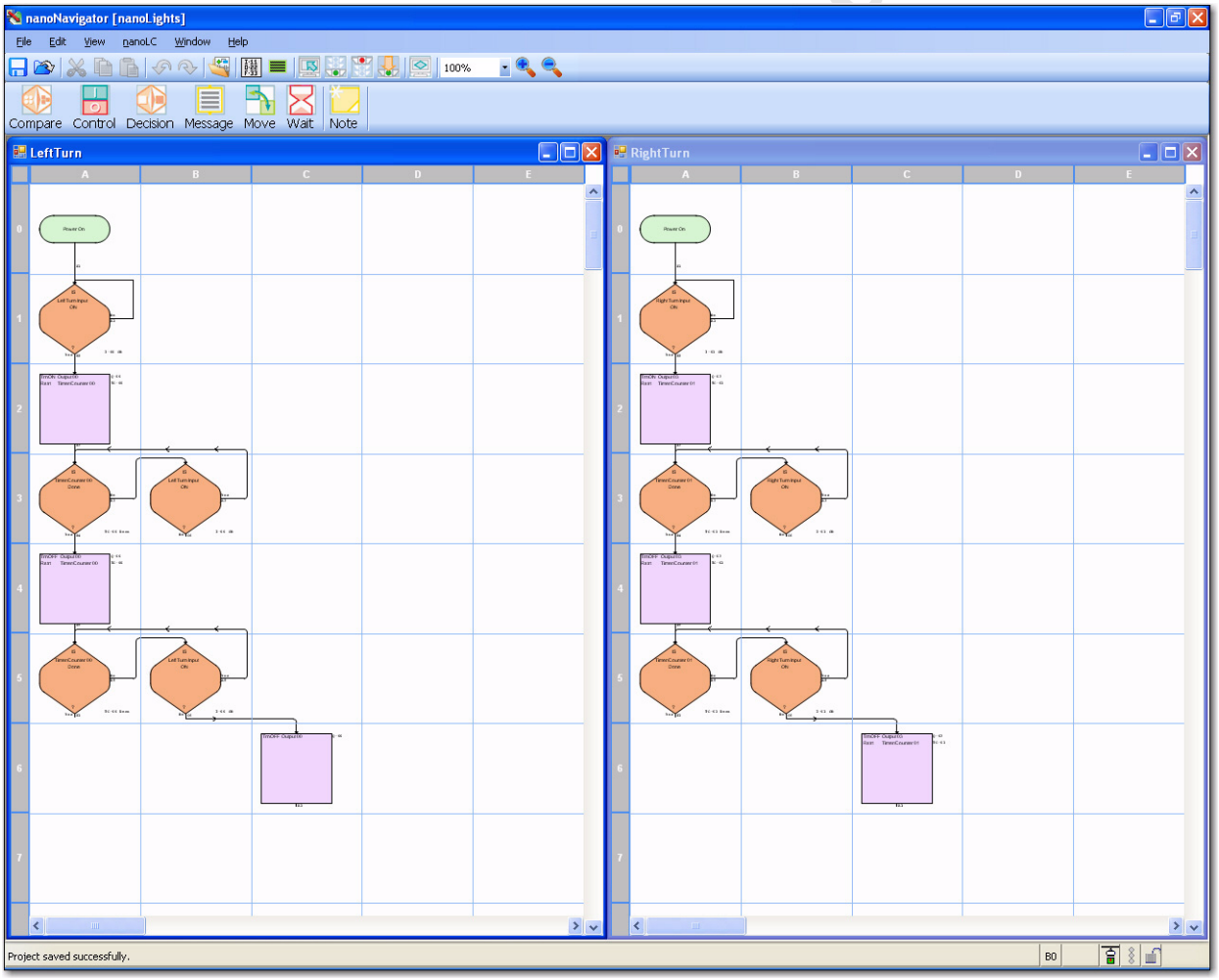

Figure 3-7 Vertically tiled flow chart windows

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To display more than one chart at a time:

– Select the “Window…Cascade” menu to show all open charts one behind the other, slightly offset.
– Select the “Window…Tile Vertically” menu to display all open charts in a vertical arrangement as shown in Figure 3-7.
– Select the “Window…Tile Horizontal” menu to display all open charts in a horizontal arrangement.

Charts that are minimized are not displayed using the “Window…” commands.

3.4 Editing Flow Charts

nanoNavigator provides intuitive Windows-style editing capability to move or cut and paste flow chart blocks from one grid location to another. Many functions are available with a mouse right-click, or use the Main toolbar buttons as described:

To select flow chart elements for editing:

1. Click a block or connection to select it.

By default, nanoNavigator is always in selection mode, except after clicking a block’s exit connector anchor that doesn’t have a flow line connecting to another block (see “Connecting Flow Chart Blocks” on page 3-28).

2. To select multiple blocks or connections, do one of the following:
   – Select a rectangular area by pressing (hold down) the left mouse button, dragging the cursor diagonally to size a rectangular area, and then releasing the mouse button. This technique selects any cell that is partially included in the selection rectangle. That means that the block in the cell and any flow lines connected to it get selected.
   – Hold the <Ctrl> key while clicking blocks or connections. Clicking a selected block or connection with the <Ctrl> key pressed deselects that object without deselecting any others.
3. Perform the action (such as cut, copy, move, or delete).

UnDo or ReDo edit operations can be performed until an operation that clears the UnDo Stack is performed.

3.4.1 Saving Flow Charts

Select the “File... Save Flow Chart” menu to save the current flow chart using the current name (the default is “Flowchart” followed by a number). Attempting to close a flow chart after modifying it displays a “Changes Made” dialog box. Click the “Yes” button to save the changes, click the “No” button to close the flow chart without saving it, or click the “Cancel” button to return to the flow chart.

To save a copy of the current flow chart, select the “File... Save Flow Chart As” menu. This menu selection displays the “Rename Chart” dialog box with the new default name. Either accept the name or type a new name, and then click the “OK” button. This creates a copy of the chart with any modifications and leaves the original chart in the project in the state it was in the last time it was saved.

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3.4.2 Cut-Copy-Paste

After selecting the object(s), use the cut (<Ctrl>+<X>), copy (<Ctrl>+<C>), and paste (<Ctrl>+<V>) shortcuts (see Figure 3-8), the Main toolbar buttons, or the “Edit” menu selections to speed up chart development. With multiple charts open, it is possible to cut/copy and paste from one chart to another, provided the charts are the same chart type.

Figure 3-8 From left to right, “Cut”, “Copy”, and “Paste” buttons

3.4.3 UnDo and ReDo

nanoNavigator supports an unlimited number of UnDo and ReDo operations. UnDo (or ReDo) operations are processed one at a time in the order they were performed. UnDo cancels the last edit operation (for example, deleting a block from a flow chart), and restores the chart to its state before the previous operation. After performing an UnDo, a ReDo can be performed. ReDo cancels the previous UnDo operation and restores the chart to its state prior to the UnDo.

nanoNavigator stores UnDo and ReDo operations in separate stacks for each chart. The UnDo stack is cleared (UnDo operations are no longer valid) when:

– a chart is saved
– the project is saved
– a nanoLC is connected
– the project is verified

The ReDo stack is cleared (ReDo operations are no longer valid) when any edit on the chart is performed other than an UnDo.

Figure 3-9 “Undo” and “Redo” buttons

To perform an UnDo or ReDo operation, do one of the following:

– click the “UnDo” or “ReDo” button on the Main toolbar.
– select the “Edit... UnDo” or “Edit... ReDo” menu.
– press the <Ctrl>+<Z> keys to UnDo or the <Ctrl>+<Shift>+<Z> keys to ReDo.

3.5 Flow Chart Blocks

This section describes the various block types, how to place them and create a flow chart.

To place a new flow chart block on the page, follow these steps:

1. In the Toolbar, click the button of the block type to place.
2. Click in the desired location (cell) on the drawing page.

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3.5.1 Enable Block

The Enable block always appears at the top of a flow chart. It allows the flow chart to begin executing. It can contain an expression that conditionally activates the flow chart while the project is running. To develop the control program, add flow chart blocks below the Enable block.

The Enable block is in the upper-left, grid cell A0, in a new flow chart (see Figure 3-10). It has the following characteristics:

– The Enable block is the first block of every flow chart. It has a single exit from which flow passes on to the rest of the control program. The Enable block cannot be deleted, copied, or moved on the drawing area.

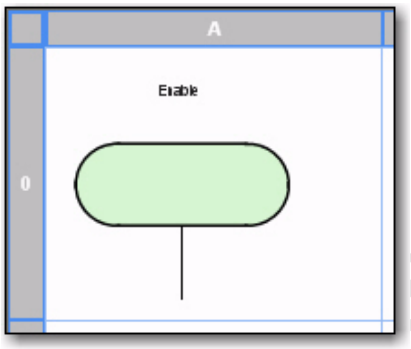

Figure 3-10 Every new flow chart opens with a predefined Enable block

– An empty Enable block (no expression created) causes a flow chart to always run.
– At runtime, the enable block is green if the flow chart is active. If it's red, the flow chart is inactive, and if it's gray, the project isn't running.

Expressions can be added to the Enable block to set conditions for running the chart. To add statements to the expression using logical operators, double-click the block. The result of the expression is either TRUE or FALSE, enabling or disabling the flow chart respectively.

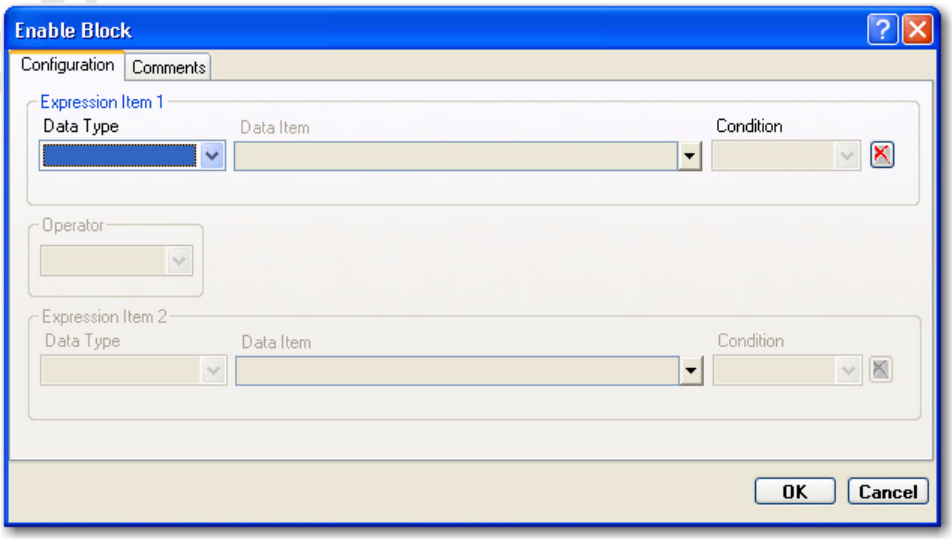

Figure 3-11 The “Enable Block” dialog box

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The AND and OR “Operator” in the dialog box permits addition of a second Boolean condition to the expression. AND has greater precedence than OR (in other words AND expressions are evaluated before OR expressions, and then they are evaluated from top-down). nanoLC supports one or two Boolean conditions in an Enable block.

– nanoLC evaluates the Enable block every scan, at the time when the flow chart executes (based on the position of the flow chart in the flow chart list—see “Changing Execution Order” on page 3-8. The flow chart only runs if its expression is true at the start of the scan.
– On the first scan or whenever the Enable block expression transitions from FALSE to TRUE, flow chart execution starts at the Enable block output. Otherwise, execution starts where it left off the previous scan.

Table 3-1 defines all possible Enable block combinations. This table shows valid data item types and the conditions that appear in the “Condition” drop-down list. For example, it is possible to test to see if an Input is “ON” or “OFF”.

Table 3-1 Valid Enable Block Expression[1]

Data Item Type	ON	OFF
Input	X	X
Output	X	X
Flag	X	X

[1] X=valid

3.5.2 Branching Blocks

Branching blocks (both Decision and Compare blocks) perform a test and determine which of two paths to take after the test. Each branching block has one entry point and two exit points indicating Yes and No paths from the block. By default, the bottom connector is the Yes path, and the right side is the No path. For more information on branching blocks, see “Types of Branching Blocks” on page 8-5.

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Place a branching (Decision or Compare) block by clicking the respective Block toolbar button, and then clicking in the desired location in the drawing area. Both Decision and Compare blocks appear as diamonds in the flow chart (see Figure 3-12).

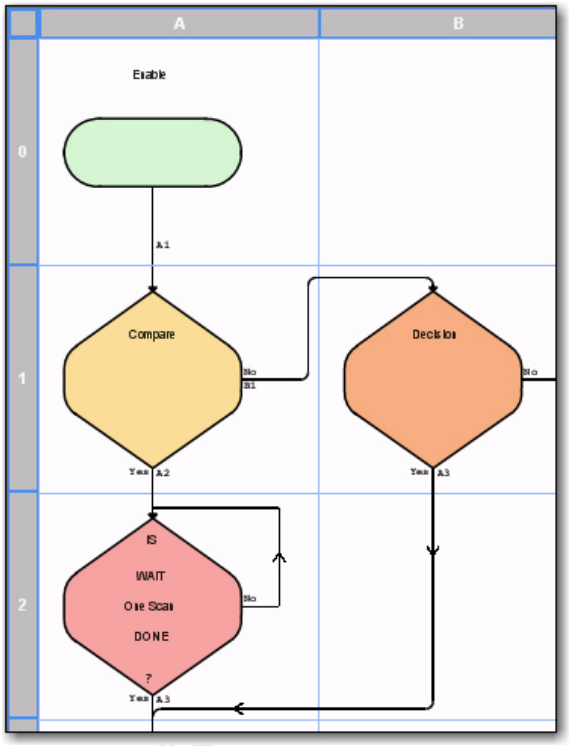

Figure 3-12 Decision and Compare blocks appear as diamonds

Compare Block Button

3.5.3 Compare Block

The Compare block can make a numerical comparison. Flow follows one of the two exit paths of the Compare block based on the result of the comparison. The type of comparisons available are less than (<), equal to (=), greater than (>), greater than or equal to (>=), less than or equal to (<=), and IsEven. There are also special direct time and date comparison operations for date, time, day of week, day of month, and day of year.

To compare Boolean values, use the Decision Block (see “Decision Block” on page 3-19).

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Double-click the Compare block to edit its expression. This displays the “Compare Block... Configuration” tab (see Figure 3-13). This example compares the register “R-01” with the name “Big Number Register” and register “R-07” that has the default name.

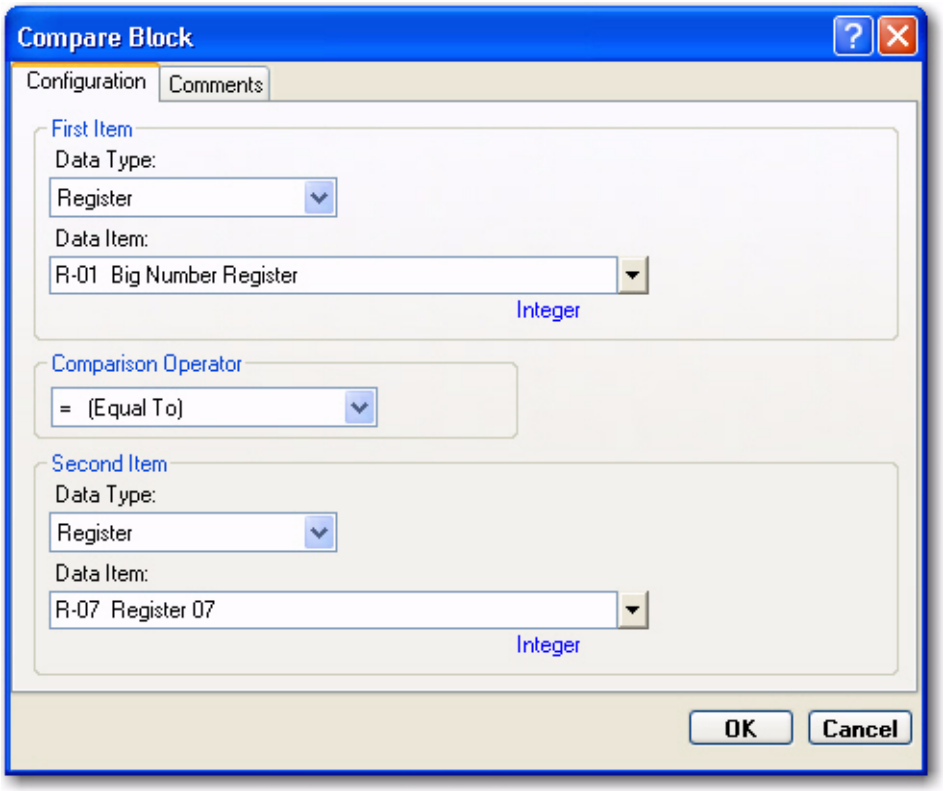

Figure 3-13 “Compare Block... Configuration” tab

When using a constant in the Compare Expression, the variable operand must be the First Item and the constant must be Second Item.

Both Registers and Timer/Counters have subtypes. The default subtype of both is “Unconfigured”. If selecting an unconfigured type for the first operand, nanoNavigator prompts for selection of its type. The subtype of the second operand must match the subtype of the first operand. Its drop-down list only shows operands with matching or unconfigured subtypes. If selecting an unconfigured item, nanoNavigator permits changing the subtype to match the type of the first operand.

When comparing “Current Date” or “Current Time” or a register with a subtype of “Date” or “Time of Day”, choose which components of the date or time to include in the comparison. For instance, to perform a date compare between the day and month, ignore the year. Likewise, to perform a time compare between minutes, ignore the hours and seconds.

In the example shown in Figure 3-13, the nanoLC will compare the register R-01 data item to see if it is equal to R-07 when this block executes. If it is, control will pass through the “Yes” path to the next block in that path. If not, control passes through the “No” path to the next block in that path.

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Editing a Compare Block

To edit a Compare block expression, follow these steps:

1. While in Selection Mode, double-click the Compare block to open the “Compare Block... Configuration” tab (see Figure 3-13).
2. Click the “Data Type” drop-down to select the data item type. Only valid data types appear in the list. Available types are Register, Timer/Counter, Analog Input, Message Input, Current Date, Current Time, Current Day of Week, Current Day of Month, and Current Day of Year.
3. For Register, Timer/Counter, Analog Input, and Message Input, enter the “Data Item” using one of the following techniques:
   – Enter the data item number, for example “1” or “01”. The type is known because it is already selected.
   – Enter the data item ID (“DI”), for example “I-01”. When tabbing to the next field, nanoNavigator displays the data item name associated with the ID.
   – Use the drop-down button to display the list of data items that correspond to the selected data item type. The drop-down list only shows data items of the “Type” selected.

If selecting an unconfigured Timer/Counter, a small dialog box opens with a drop-down list that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or “Duration (mSec)”.

4. Use the “Comparison Operator” drop-down to select the desired comparison.
5. Use the “Second Item” group to select a “Data Type” and “Data Item”.
6. Click the “OK” button.

Yes/No path selection

By default, the connection that goes out the bottom of the Compare block is the “Yes” path; the exit on the right is the “No” path. The “Compare Block... Comments” tab permits adding a block comment and swapping the positions of the Yes and No exit paths (another way is to right-click a block, and then select “Swap Yes/No Connectors” from the pop-up menu). Entering the block’s cell address (“Grid and Cell Address” on page 3-5) explicitly sets or modifies the target block of the “Yes” or “No” connector.

Compare Block Summary

Table 3-2 defines all possible Compare block combinations.

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Table 3-2 Valid Comparisons in a Compare Block[1]

		Data Item Type							Constant Value								
Data Item Type	**Sub-type**	**Integer**	**Date**	**Time**	**DoW**	**HMS**	**mSec**		**Integer**	**Date**	**Time**	**DoW**	**HMS**	**mSec**		**IsEven**	**Display Format**
Register	Integer	X							X							X	xxxxxxxx
	Date		X							X							dd/mm/yy
	Time			X							X						hh:mm:ss
	DoW				X							X					Sun-Sat
	HMS					X							X				hh:mm:ss
	mSec						X							X			xxxx.xxx
Timer/Counter	Counts	X							X							X	xxxxxxxx
	HMS					X							X				hh:mm:ss
	mSec						X							X			xxxx.xxx
Analog In		X							X							X	xxxxxxxx
Analog Out		X							X							X	xxxxxxxx
HS Counter		X							X							X	xxxxxxxx
Message Input	Integer	X							X							X	xxxxxxxx
	Date		X							X							dd/mm/yy
	Time			X							X						hh:mm:ss
	DoW				X							X					Sun-Sat
	HMS					X							X				hh:mm:ss
	mSec						X							X			xxxx.xxx
Current Date			X							X							dd/mm/yy
Current Time				X							X						hh:mm:ss
Day of Week					X							X					Sun-Sat
Day of Month		X							X								xx
Day of Year		X							X								xxx
	Notes: DoW is Day of the Week																

[1] X=valid

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3.5.4 Decision Block

Decision Block Button

The Decision block evaluates a Boolean expression as true/false. The expression may consist of one or more bits. The Decision block has one entry point and two exit points (Yes/No), based on the Boolean decision. Use the “Decision Block” dialog box to select the bit(s) to be evaluated, which are of these types:

- Flag
- Input
- Output
- Keypad key
- Timer/Counter
- High-Speed Counter

To perform a non-Boolean comparison, use the Compare block (see “Compare Block” on page 3-15).

- The AND and OR “Operator” in the dialog box permits adding a second Boolean condition to the expression. Expressions are evaluated from top-down. nanoLC supports one or two Boolean conditions in one Decision block. Double-click the Decision block to edit its expression. This displays the “Decision Block... Configuration” tab (see Figure 3-14).

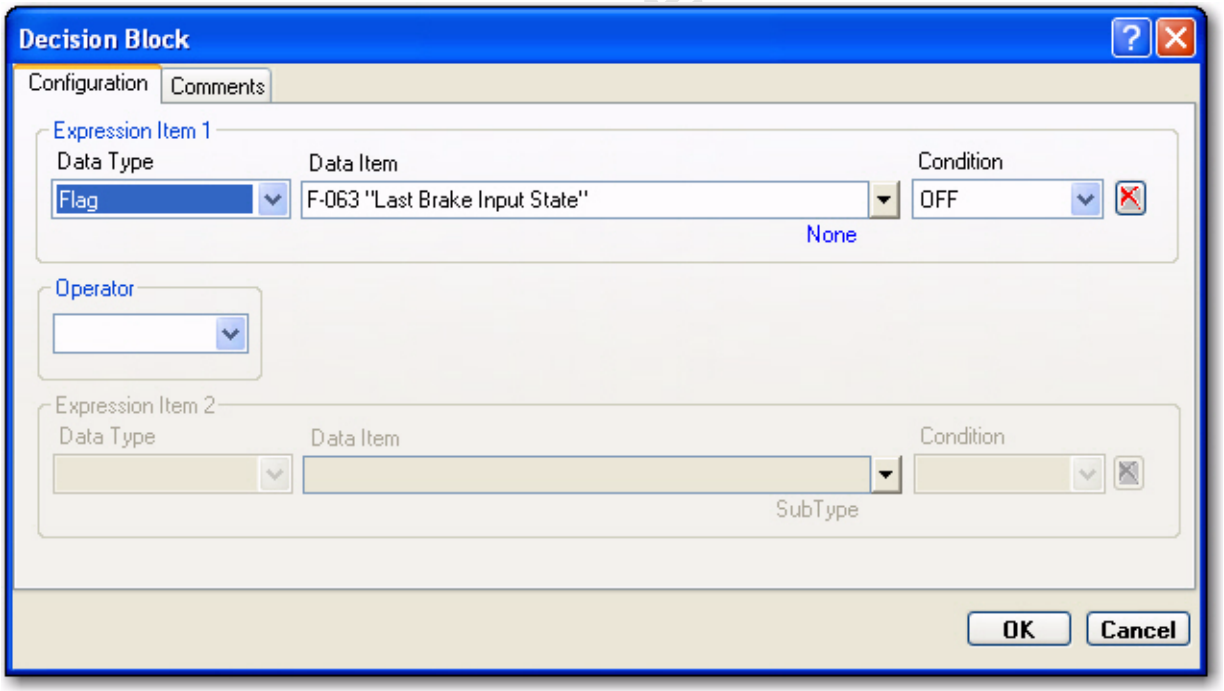

Figure 3-14 “Decision Block... Configuration” tab

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Editing a Decision Block

To edit a Decision block expression, follow these steps:

1. While in Selection Mode, double-click the Decision block to open the “Decision Block... Configuration” tab (see Figure 3-14).
2. Click the “Data Type” drop-down list to select the data item type. Only valid data types appear in the list. Available types are Flag, Input, Output, Keypad Key, Timer/Counter, and High-Speed Counter.
3. Enter the “Data Item” using one of the following techniques:
   – Enter the data item number, for example “1” or “01”. The type is known.
   – Enter the data item ID (“DI”), for example “I-01”. When tabbing to the next field, nanoNavigator displays the data item name associated with the ID.
   – Use the drop-down button to display the list of data items that correspond to the selected data item type. The drop-down list only shows data items of the “Type” selected.

When selecting an unconfigured Timer/Counter, a small dialog box appears with a drop-down list that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or “Duration (mSec)”.

4. Use the “Condition” drop-down list to set the condition desired.

Or use the <Tab> key to highlight the field and use the first character to toggle the value. For example, typing the letter “o” toggles among values beginning with the letter “o”.

Use the button on the right side of the conditional expression line to delete (make all fields blank) the expression.

5. Click the “OK” button.

Yes/No Path Selection

By default, the connection that goes out the bottom of the Decision block is the “Yes” path; the exit on the right is the “No” path. The “Decision Block... Comments” tab permits adding a block comment and swapping the positions of the “Yes” and “No” exit paths (another way is to right-click a block, then select “Swap Yes/No Connectors” from the pop-up menu). Entering the block’s cell address (“Grid and Cell Address” on page 3-5) explicitly sets or modifies the target block of the “Yes” or “No” connector.

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Decision Block Summary

Table 3-3 defines all possible Decision block combinations.

Table 3-3 Valid Comparisons in a Decision Block[1]

		Bits		Timer/ Counter				HS Counter			
Data Item Type	**Mode**	**On**	**Off**	**Done**	**Not Done**	**Running**	**Not Running**	**Done**	**Not Done**	**Enabled**	**Disabled**
Input		X	X								
Output		X	X								
Flag		X	X								
Key pad entry		X	X								
Timer/Counter	HMS			X	X	X	X				
	mSec			X	X	X	X				
	Counts			X	X						
HS Counter								X	X	X	X

[1] X=valid

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3.5.5 Action Blocks

nanoNavigator has four types of action blocks: Control, Message, Move, and Wait (see Figure 3-15). For more information on action blocks, see “Types of Action Blocks” on page 8-5.

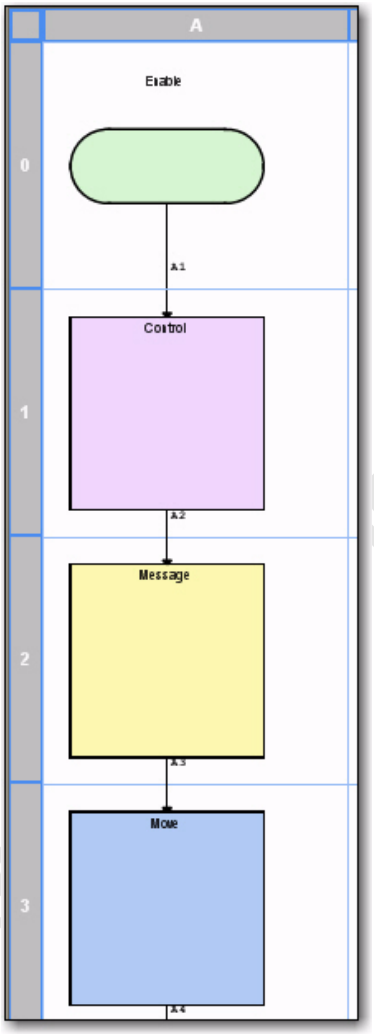

Figure 3-15 Action blocks

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Control block Button

3.5.6 Control Block

The Control block is the most basic building block of a flow chart. It is one of the action blocks of the nanoNavigator (see “Types of Action Blocks” on page 8-5). Its job is to do the discrete actions listed in its expression list. A Control block is capable of setting bits On or Off (flags or outputs), and doing internal timer or counter operations.

Unlike ladder logic, these actions are *latched*. In other words, when turning an output on, it stays on until the flow chart (or another flow chart) turns it off. The only exception is the pulse output, which automatically turns off after the specified duration (entered in the Data Item grid), and the Flash Output action, which causes the Output to turn on and off at the configured period until the output is turned off.

Use the “Control Block” dialog box to select the action(s) for the control block:

– Turn a Flag or Output on or off
– Pulse or Flash an Output (where a pulse turns off after a specified duration, and a flash cycles on and off at a 50% duty cycle until it is either turned off or on)

A Pulse output with a duration of 0 (zero) causes the output to be on for a single scan only.

– Start, stop, reset, or restart a Timer
– Increment, Decrement, or reset a counter

The “Control Block” dialog box can contain up to four actions, which the nanoLC executes in list order. Double-click the Control block to edit its expression. This displays the “Control Block... Configuration” tab (see Figure 3-16).

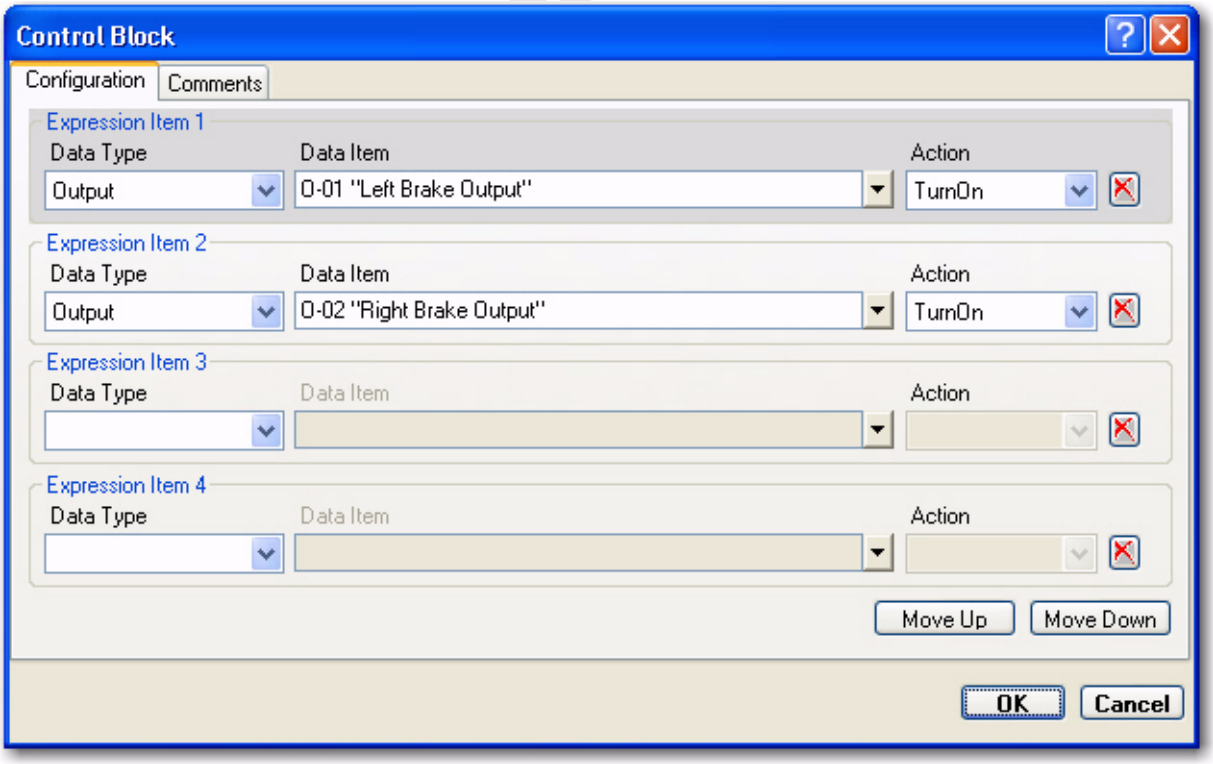

Figure 3-16 “Control Block... Configuration” tab

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Since actions in the Control block execute in the order they appear, Control blocks permit reordering actions. To reorder an action, select it (it appears highlighted), and then use the “Move Up” or “Move Down” buttons to move the selected action. For these buttons to be available, there must be more than one action defined in the block.

The order rarely makes a difference. This feature is primarily to improve readability. It does, however, make a difference when starting a timer, and then resetting that timer, as opposed to the inverse. This is applicable if the timer was previously stopped but did not complete (elapsed time operations).

Editing a Control block

To edit a Control block’s expression, follow these steps:

1. Double-click the Control block to open the “Control Block... Configuration” tab (see Figure 3-16).
2. Click the “Type” cell, and select the data item type desired.
3. Enter the “Data Item” using one of the following techniques:
   – Enter the data item name in the “Data Item” field. While typing, nanoNavigator attempts to auto-complete the name. When tabbing to the next field, nanoNavigator displays the data item ID associated with the data item name.
   – Enter the data item ID (“DI”), for example “I-01”. When tabbing to the next field, nanoNavigator displays the data item name associated with the ID.
   – Use the drop-down button to display the list of data items that correspond to the selected data item type.

When selecting an unconfigured Timer/Counter, a small dialog box displays with a drop-down that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or “Duration (mSec)”.

4. From the “Action” drop-down list, select the action desired. The choices available in the drop-down depend on the data item type selected.

Use the button on the right side of the conditional expression line to delete (make all fields blank) the expression.

5. Repeat steps 2. through 4. as required for additional expressions. A block must have at least one expression. After entering more than one expression, the “Move Up” and “Move Down” buttons become available. These buttons permit re-ordering the expression, since the nanoLC executes them in the order they appear in this dialog box. Select one of the expressions, and then click the desired button to move it in the list.
6. Click the “OK” button.

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Message Block button

3.5.7 Message Block

When configured with the optional Operator Panel, the nanoLC can display messages to the user. Messages can contain static text, dynamic values from any data item, and data entry requests. Double-click the Message block to edit its expression. This displays the Configuration page of the “Message Block” dialog box (see Figure 3-17).

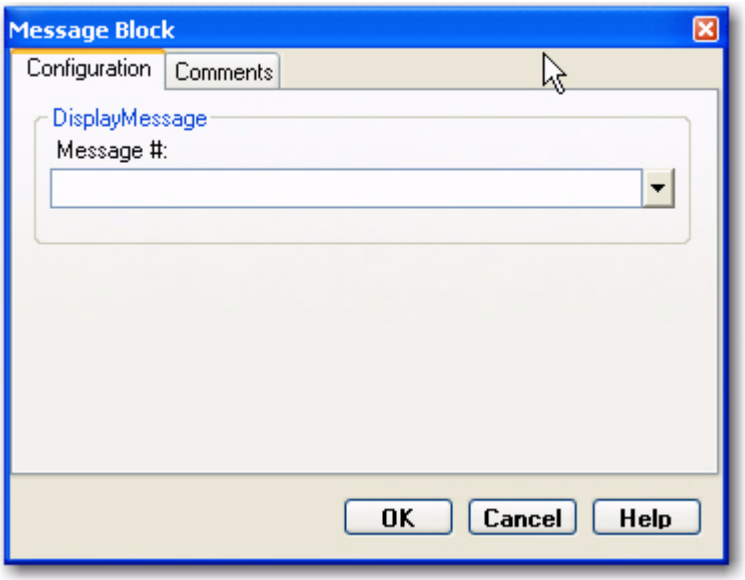

Figure 3-17 “Message Block... Configuration” tab

The drop-down list at the top of the page permits selection of a message number (from 0 to 31). The Message Editor permits entry or modification of the message associated with that message number (see “Using the Message Editor” on page 3-31).

Only configured messages appear in the “Message #” drop-down list.

Obtaining User Input

As defined in “Inserting Data Entry Items” on page 3-32, messages can include data variables that prompt for user input. As the operator enters data through the keypad on the Operator Panel, the Operator Panel processor validates the input data according to the data type specified. Once the operator completes data entry and presses the “OK” key, the Operator Panel passes the input to the flow chart and sets the “Message Input Ready” key for one scan cycle.

Flow charts that require operator input must continue to look for the “Message Input Ready” key or some overriding condition that would inhibit data from being entered on every scan after sending the message requesting input.

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3.5.8 Move Block

Move Block Button

The Move block simply moves data from one location to another. Doing a move from one data item to another simply moves (copies) the data of the first data item into the second data item. The value of the first data item is preserved.

The “Move Block... Configuration” tab (see Figure 3-18) permits definition of the “From” and “To” data fields. After selecting the “Data Type”, the “Data Item” drop-down list displays only those data items for the type selected.

For more information on how the Move block performs powerful data manipulations, refer to “Using the Move Function” on page 5-13.

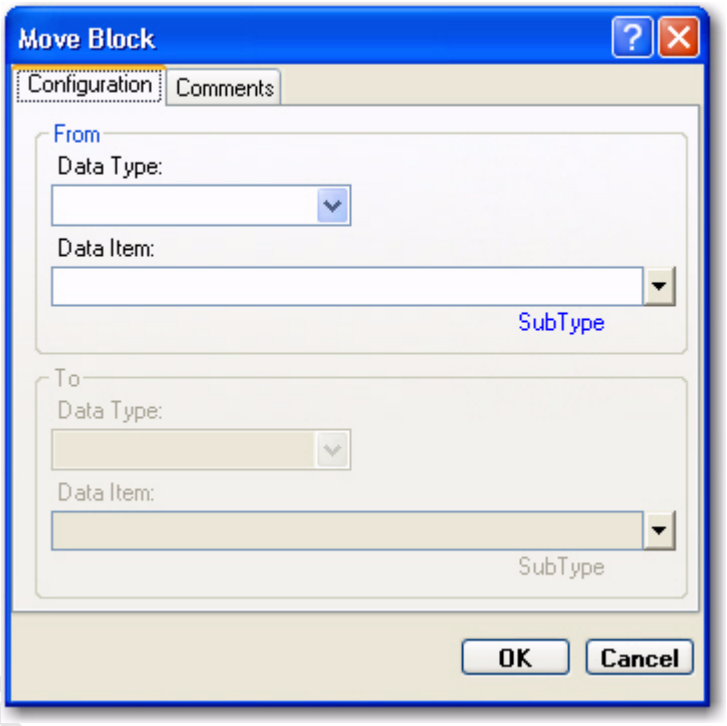

Figure 3-18 “Move Block... Configuration” tab

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3.5.9 Wait Block

Wait Block Button

The Wait block inserts a wait period in the execution of the flow chart. Configure the wait period in seconds (with millisecond resolution) or hours, minutes, and seconds. If the wait duration is zero, the block defaults to one scan cycle.

To configure the wait time:

1. Double-click the Wait block to display the “Wait Block... Configuration” tab (see Figure 3-19).

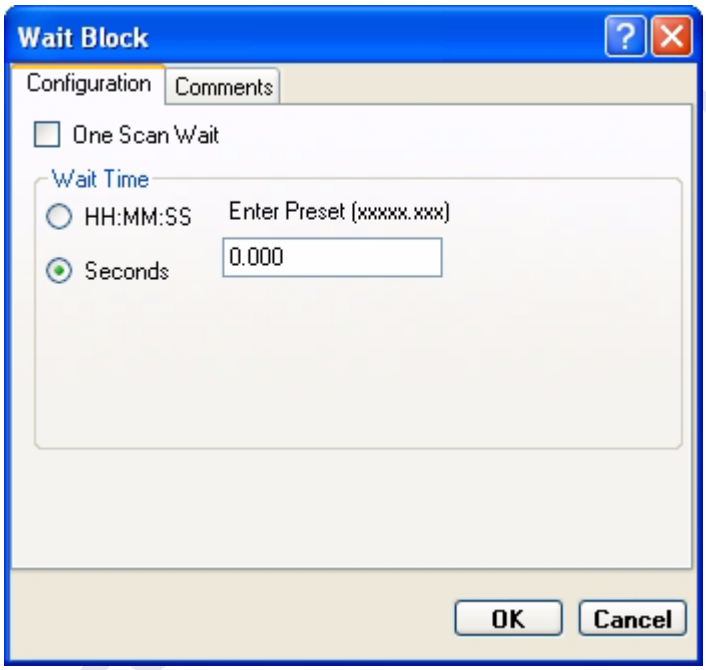

Figure 3-19 “Wait Block... Configuration” tab

2. Do one of the following:

   To wait for one scan cycle, click the “One Scan Wait” check box.

The duration changes to zero if it was previously non-zero, and “Wait Time” becomes unavailable.

   To wait for a specified period of time:
   - Click either the “HH:MM:SS” or “Seconds” radio button.
   - Enter the duration in hours, minutes, and seconds or seconds and milliseconds in the field using the format shown.

If the duration is zero, the Wait block defaults to one scan cycle. The Wait block automatically selects the “One Scan Wait” check box upon clicking the “OK” button.

3. Click the “OK” button.

During the wait period, many scan periods may pass. However, the flow chart with the Wait block will not execute further until the wait period ends. On the scan when the wait time expires, flow chart execution resumes at the next block following the Wait block.

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The Wait block is easier to use than constructing a timing loop for a delay in the flow chart, since there is no need to create a timer data item or create the flow chart loop. When a Wait block is executing, no other blocks in the current flow chart execute until the wait completes. Other flow charts continue to execute normally as long as they are enabled.

3.5.10 Notes

Notes don't actually appear in a block. They can appear anywhere on the flow chart page and don't connect to or affect program flow.

3.6 Connecting Flow Chart Blocks

To draw flow chart block connecting lines, follow these steps:

1. Move the cursor to the bottom (or side for Decision and Compare blocks) connecting point of a block that doesn't have an outgoing flow line. The connecting point turns orange (or the specified color) to indicate a potential outgoing connector pointer, and the cursor changes to the connector pointer.

If the Flow Chart Editor is inadvertently in connect mode, press the <Esc> key to switch back to select mode.

2. Click the outgoing connector point.
3. Move the cursor to the next block's top (incoming) connector point, which will turn green (or the specified color).
4. Click the incoming connector to complete the line. The cursor changes back to the selector pointer.

nanoNavigator supports automatic routing from one block to another, so it is only necessary to click the outgoing connector of one block and the incoming connector of the next to generate the flow line. It is always possible to manually draw the flow line by clicking from point-to-point to route the line.

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For example, Figure 3-20 shows a simple project flow chart with all required connecting lines.

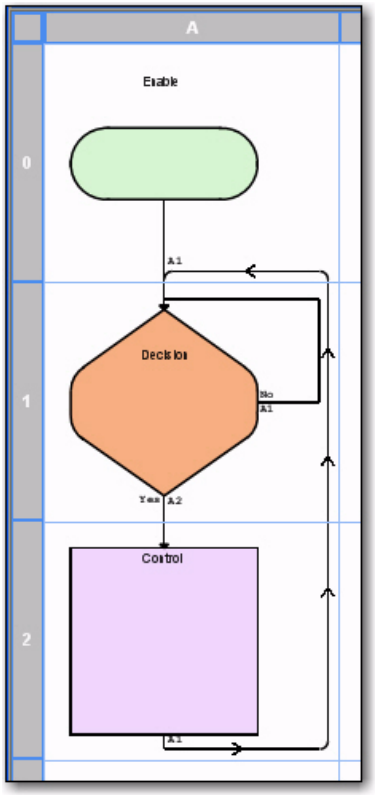

Figure 3-20 Sample flow chart with flow lines connecting all blocks

Unlike CAD programs that permit ending a line where it intersects another line, nanoNavigator requires guiding the pending connection to the common destination.

If the connector appears as a red line, it is not properly connected. This can occur if the connection doesn't meet the input connection point of the block. Try moving the end point of the line until the region that represents the block's input connection becomes highlighted.

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3.7 Entering Block Comments

Enter comments about a block to summarize actions taken in the block. This is useful to provide an overview version of the flow chart. Specify whether flow charts should display block comments or block expressions by toggling the “View... Block Comments” menu.

To enter or edit block comments:

1. Right-click on the block and select “Block Comments” from the pop-up menu. The “Comments” tab of the properties dialog box (see Figure 3-21) appears.

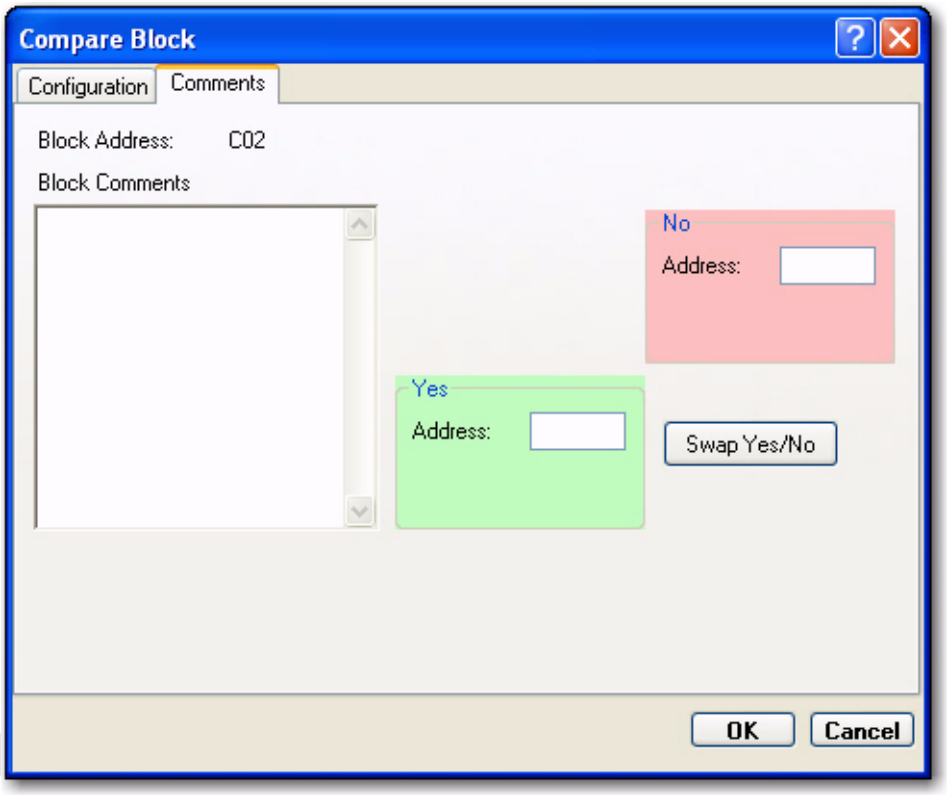

Figure 3-21 “Compare Block... Comments” tab

2. Enter the block comment, and then click the “OK” button.

The “Address” fields for “Yes” and “No” in the “Compare” and “Decision” block “Comments” tabs permit entry of a cell address (see “Grid and Cell Address” on page 3-5) without drawing a connection.

3. To view all block comments on the flow chart instead of expressions, select the “View... Block Comments” menu.

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3.8 Using the Message Editor

The Message Editor (see Figure 3-22) permits definition of up to 32 four-line messages to use during project execution. Each line can have up to 20 characters, and lines can contain any combination of static text, data item output, and user-requested input.

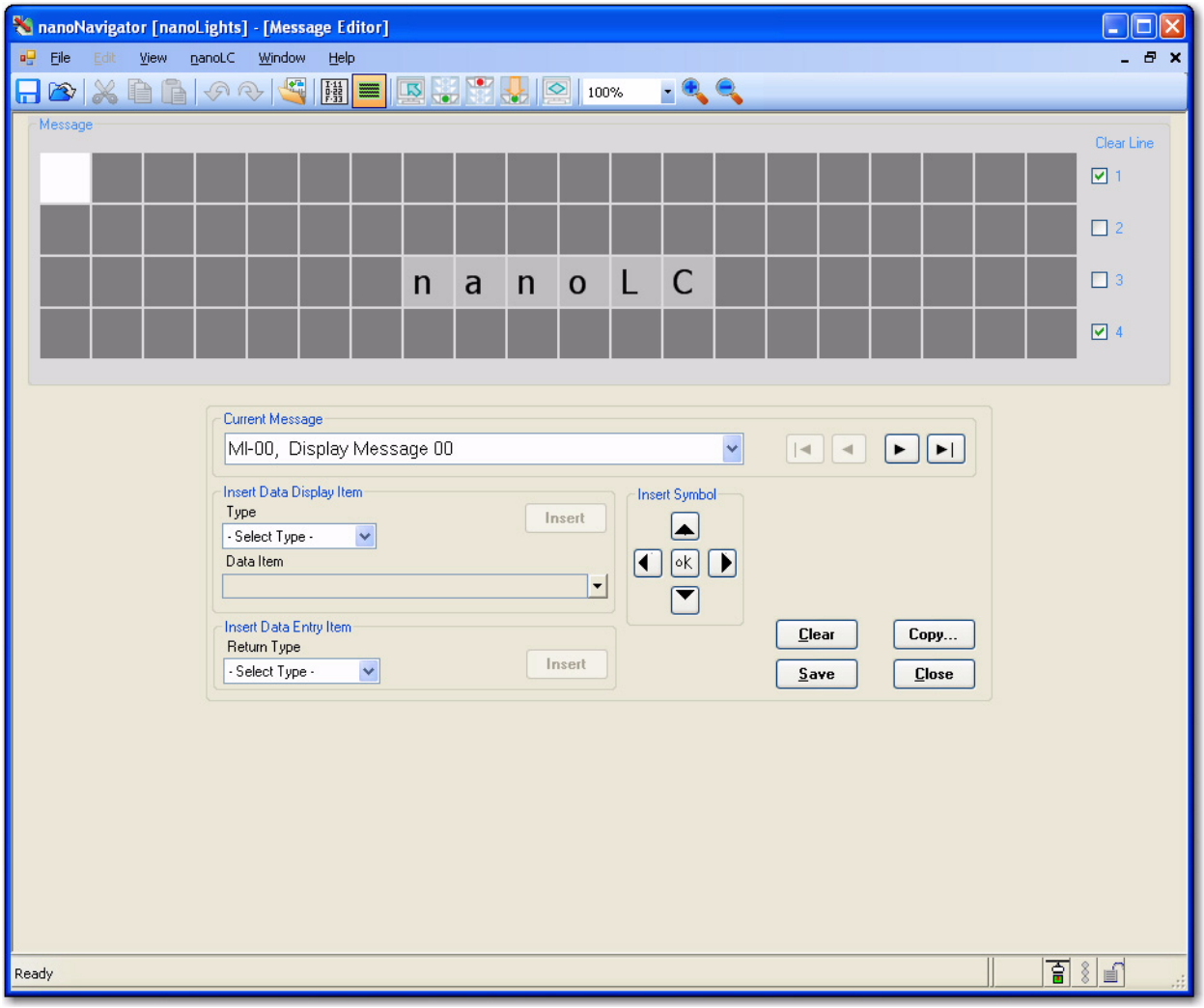

Figure 3-22 Use Message Editor to define and edit messages in a project

3.8.1 Displaying the Message Editor

Edit Messages Button

Click the “Edit Messages” button in the Main toolbar, or select the “View... Message Editor” menu to display the Message Editor in the nanoNavigator workspace. Once open, the Message Editor is like any other window. Display the Message Editor by selecting it from the “Windows” menu, selecting it again from the “View” menu, or pressing <Ctrl>+<F6> or <Ctrl>+<Shift>+<F6> until it appears on top. When using “Windows... Cascade” or one of the “Tile” options with the Message Editor open, the Message Editor appears along with all open charts.

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3.8.2 Creating and Editing Messages

To create or edit a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to create or edit from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Enter any static text, data display items (see below), data entry items (see below), and/or symbols in the fields.

The nanoLC does not clear any message cells that aren’t explicitly overwritten. To ensure that an old message is cleared before writing a new one, leave the “Clear Line” check box selected (selected by default) for the line(s) to clear prior to displaying new text.

The symbols that appear in the “Insert Symbols” list correspond to special keys that are available on the nanoLC.

4. Click the “Save” button to save the message.

Inserting Data Display Items

To display a data item, use the “Insert Data Display Item” group as follows:

1. Select a cell of the message.
2. Select the data item “Type” from the drop-down list.
3. Select the data item from the “Data Item” drop-down list.
4. Click the “Insert” button to insert the data display item in the message.

Inserting Data Entry Items

To have the user enter a data item, use the “Insert Data Entry Item” group as follows:

1. Select a cell of the message.
2. Select the data item “Return Type” from the drop-down list.
3. Select the data item from the “Data Item” drop-down list.
4. Click the “Insert” button to insert the data entry item in the message.

3.8.3 Copying Messages

To copy a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to copy from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Click the “Copy...” button. This displays the “Copy Message” dialog box.
4. Use the “Copy Message” dialog box to enter a message number or use the up/down buttons to select a message number. The number entered is the destination for the copy operation.

An asterisk (*) in the number field indicates the message has been configured previously.

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5. Click the “OK” button. The copy operation executes immediately unless the destination message already has text or fields. In that case, a warning message appears before the operation completes.

3.8.4 Clearing Messages

To clear a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to clear from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Click the “Clear” button. This displays a confirmation dialog box.
4. Click the “Yes” button to clear the message.

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Section 4

This section provides information about:

- Managing charts using Chart Explorer
- Using the Ladder Chart Editor and creating ladder charts
- Using the Message Editor

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4 Ladder Chart Programming

4.1 Exploring Ladder Charts

When a new project is created, the user must choose to create either a flow chart (see “Flow Chart Programming” on page 3-3) or ladder chart. A ladder chart (or ladder diagram) expresses the program logic using graphical symbols similar to relay circuits. When a new project is selected, the “Select Type of First Chart” dialog box appears. Click the “Create Ladder Chart” button to create a new ladder chart.

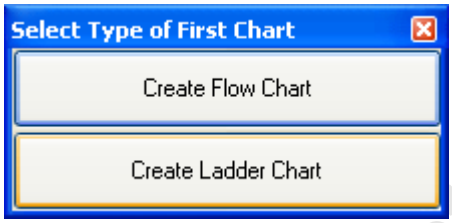

Figure 4-1 “Select Type of First Chart” dialog box

To create additional charts in a project, select “File… New Chart…” from the menu and choose either the “Flow Chart” or “Ladder Chart” option. Alternatively, new charts can be created from within the Chart Explorer by clicking the “New” button.

Flow charts and ladder charts can both be utilized within a project.

A flow chart cannot be opened using the Ladder Chart Editor and a ladder chart cannot be opened using the Flow Chart Editor.

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Upon creation of a ladder chart, an Enable block is automatically placed in the first cell (A0). Also, the first rung is automatically created and populated using a contact and a coil. Down the left side is the “power” line.

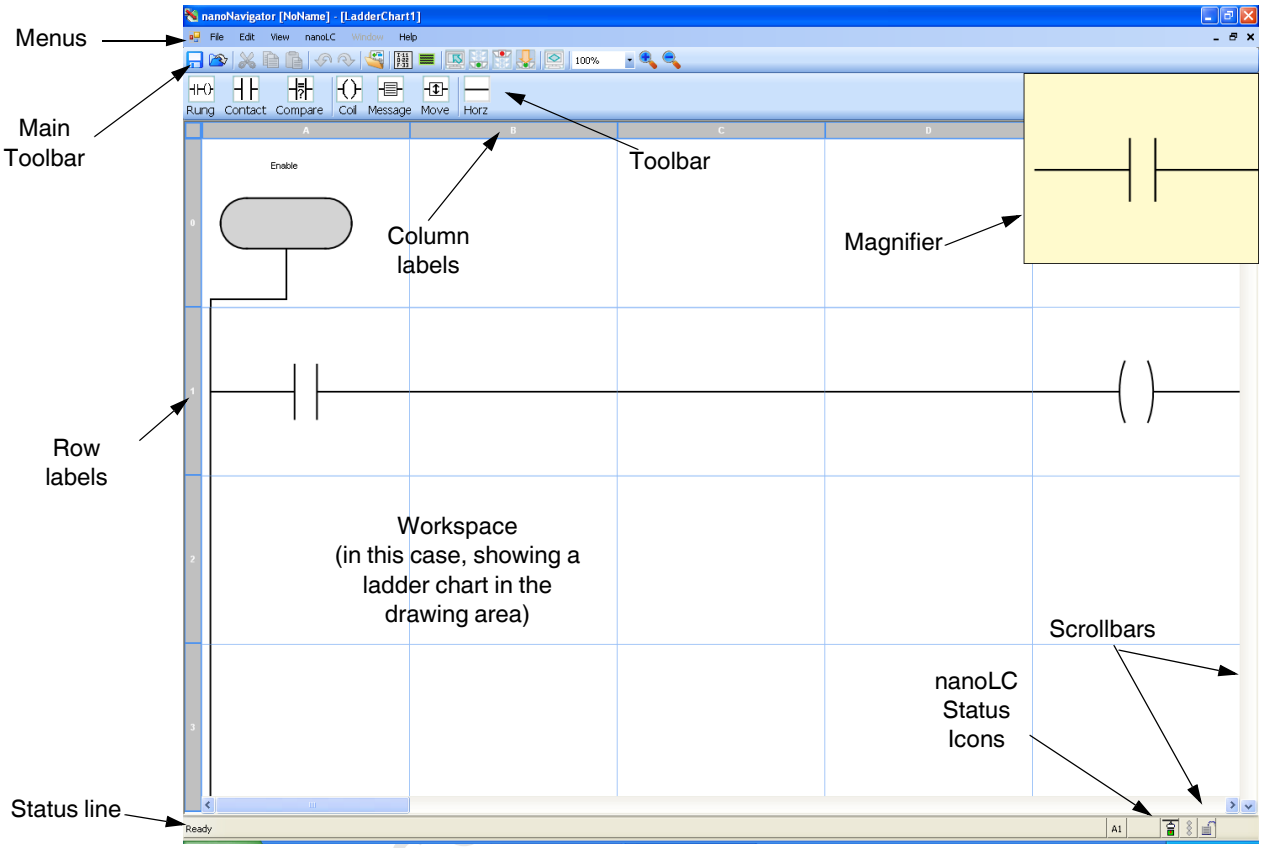

Figure 4-2 nanoNavigator showing a ladder chart window

The key elements of the nanoNavigator ladder chart window, shown in Figure 4-2, are:

- Menus: Provide access to all the commands in nanoNavigator, as well as online help.
- Toolbar: Contains toolbar buttons for placing coils and contacts onto ladder charts. With the “View... Auto-hide Toolbar” menu selected (the default), the Toolbar only appears with a Chart Editor visible. With this menu unselected, the Toolbar also appears in the Data Item Editor and Message Editor, but it is only active in the Ladder Chart Editor.
- Main Toolbar: Contains toolbar buttons for cut, copy, and paste. It also contains buttons to quickly access selections from the “View” and “nanoLC” menus (see “Using the Main Toolbar” on page 4-5).
- Column labels: Provide a guide for locating shapes in the drawing area. nanoNavigator provides five columns for ladder chart blocks.
- Row labels: Provide a guide for locating shapes in the drawing area. nanoNavigator provides an unlimited number of rows limited only by available memory.
- Drawing area: Build ladder charts in the drawing area. Horizontal and vertical grid lines appear by default. Coils and contacts must appear within a grid cell with only one element per cell.

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– Magnifier: Appears when hovering the mouse pointer over a populated cell in the ladder chart. Provides a more readable version of the cell's contents and labels. Toggle this feature ON (check mark present) or OFF by clicking the "View... Magnifier" menu. By default, the Magnifier is ON.
– Scrollbars: Use the scroll bars to bring portions of the drawing area that are off-screen into view. To scroll in small increments, click the arrows at the end of each scroll bar.
– Status line: Provides information about nanoNavigator or selected shapes. Status elements include a Message area and nanoLC status icons. nanoLC status icon area presents three icons (from left to right) that reflect the state of the nanoLC. The icons are:
  – Connection state: Connected or not
  – Running state: Unknown (not connected); Running; Stopped
  – Locked state: Unknown (not connected); Locked; Unlocked

Connection State Icon (connected)

Running State Icon (running)

Locked State Icon (unlocked)

Figure 4-3 nanoLC status icons

4.1.1 Using the Main Toolbar

The Main toolbar (see Figure 4-4) is visible by default. To toggle the toolbar on and off, select the "View... Main Toolbar" menu.

Figure 4-4 Main toolbar

From left to right, the buttons in the toolbar are:

1. Save Project: Performs the same function as the "File... Save Project" menu.
2. Open Project: Performs the same function as the "File... Open Project" menu (see "Open Existing Project" on page 2-6).

The Cut, Copy and Paste buttons do not function in the Ladder Chart Editor. They appear because it is a common toolbar with the Flow Chart Editor and future functionality is planned for these buttons.

3. Cut: Performs the same function as the "Edit... Cut" menu.
4. Copy: Performs the same function as the "Edit... Copy" menu.
5. Paste: Performs the same function as the "Edit... Paste" menu.
6. UnDo: Performs the same function as the "Edit... UnDo" menu (see "UnDo and ReDo" on page 4-12).
7. ReDo: Performs the same function as the "Edit... ReDo" menu (see "UnDo and ReDo" on page 4-12).
8. Chart Explorer: Opens the Chart Explorer (see "Chart Explorer" on page 4-7).
9. Edit Data Items: Opens the Data Item Editor (see "Using the Data Item Editor" on page 5-3).

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10. Edit Messages: Opens the Message Editor (see “Using the Message Editor” on page 4-28).
11. Start Monitoring/Stop Monitoring: Toggles depending on whether or not nanoNavigator is currently monitoring the connected nanoLC. Performs the same function as the “nanoLC... Start Monitoring” menu and the “nanoLC... Stop Monitoring” menu (see “nanoLC Monitor Window” on page 7-4).
12. Run: Starts the current project running on the nanoLC. Performs the same function as the “nanoLC... Run” menu (see “Running a Project” on page 6-7).
13. Stop: Stops the current project on the nanoLC. Performs the same function as the “nanoLC... Stop” (see “Stopping a Running Project” on page 6-7).
14. Download & Go: Downloads the project currently open in nanoNavigator to the nanoLC. This single click saves, verifies, and then downloads the project to the nanoLC. It then runs the project on the nanoLC. Performs the same function as “nanoLC... Download & Go” menu (see “Downloading a Project” on page 6-5).
15. Simulator: Starts simulation of the project (see “Connecting to the Simulator” on page 8-39).
16. Zoom Buttons: Combo Box, Zoom In and Zoom Out (see “Zooming In or Out” on page 4-7.)

4.1.2 Grid and Cell Address

The Ladder Chart Editor uses a fixed grid of five columns (labeled “A” to “E”) by any number of rows (numbered “1” to n) for placement of coils and contacts. The grid defines cells that are labeled by column letter and row number. For example, cell “A0” is the cell in the upper-left location of the chart. By default, the grid lines are visible in charts. Whether the grid lines are visible or not, cell references are by their cell address.

Columns A through D only accept contacts. Column E only accepts coils.

Turning the Grid On and Off

To turn the page grid on or off, follow these steps:

1. Select the “File... Preferences...” menu to display the “Preferences” dialog box.
2. Click the “Designer Options” tab.
3. Click the “Show Grid Lines” check box to turn the grid line on or off, respectively.
4. Click the “OK” button, and then answer any message dialog boxes that appear.

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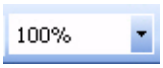
4.1.3 Zooming In or Out

Zoom Out (left) and In (right) toolbar buttons

The full design of a chart may be large and any page may be larger than the viewable Ladder Chart Editor window. The following techniques show more of the page by setting the zoom factor:

- Select the desired zoom percentage from the “View... Zoom Factor...” menu.
- Click the “Zoom In” or “Zoom Out” tools in the Main toolbar.
- Hold the <Ctrl> key and spin the middle mouse wheel (up to zoom in and down to zoom out).
- Hold the <Ctrl> key and press the keyboard minus key to zoom out or the plus key to zoom in.
- Use the “Zoom” drop-down list in the Main toolbar.



Zoom drop-down list

4.2 Chart Explorer

A project can have a total of 16 charts, in any combination of ladder and flow, with a total of approximately 500 blocks. Use multiple charts for all but the simplest projects with each chart controlling a single process, machine, or major function. A modular approach to developing chart programs makes it easier to create, verify, and maintain control projects.

Use the Verify Project (see page 7-4) to ensure the project is properly configured and does not exceed the capability of the hardware.

Once downloaded to a nanoLC, all enabled charts (flow or ladder) execute in the order they appear in the Chart Explorer. The project can programmatically control which charts execute during any given scan cycle. For more information on enabling charts, see “Enable Block” on page 4-14.

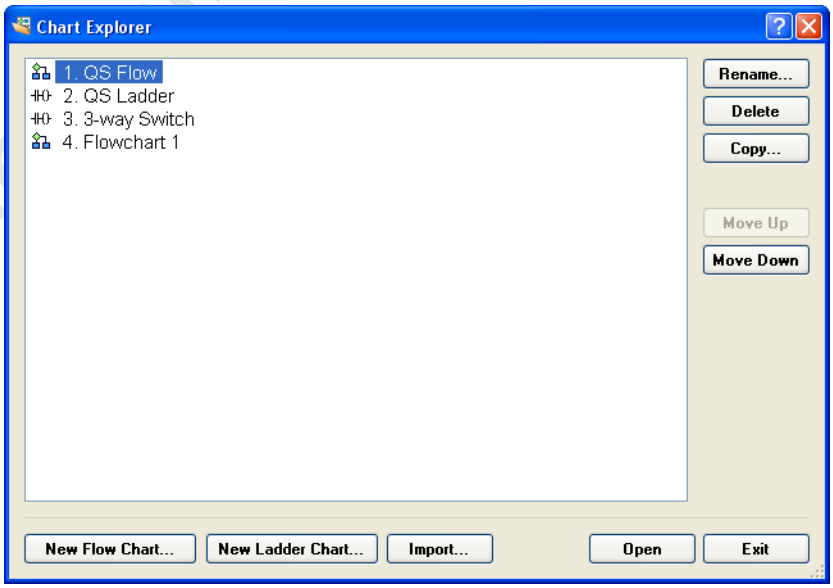


Figure 4-5 Chart Explorer

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Chart Explorer Button

To open the Chart Explorer and display a list of the charts (flow and ladder) in the project:

– Click the “Chart Explorer” button on the Main toolbar.
– Select the “View... Chart Explorer” menu.

An icon indicates the type of chart. Using the Chart Explorer automatically selects the correct chart editor (flow or ladder).

Flow charts cannot be opened using the Ladder Chart Editor and ladder charts cannot be opened using the Flow Chart Editor.

Ladder charts appear in a Ladder Chart Editor window. If the project consists of only one chart, nanoNavigator always displays it when the program starts.

If there are multiple charts in a project, nanoNavigator displays the last chart that was open when the project starts. If no chart window was open the last time the project closed, nanoNavigator displays the Chart Explorer to allow selection of a chart.

– Click the “Exit” button to close the Chart Explorer.

Alternatively, select the “File… New Chart” and choose either a flow or ladder chart from the list. To open an existing chart select the “File…Open Chart…” menu and click the desired chart from the list.

4.2.1 Opening a Ladder Chart

To open a ladder chart for editing from the Chart Explorer, double-click the chart in the list or click the chart name to select it, and then click the “Open” button.

Alternatively, the ladder chart can be selected from the “File... Open Chart...” menu.

4.2.2 Creating a New Ladder Chart

To create a new chart from the Chart Explorer, click the “New” button. The new chart will be the same type of chart as last viewed, either ladder or flow. To create a new chart of a different type, click the “New” button drop-down list on and click desired chart type.

Alternatively, select the “File… New Chart” and choose either a flow or ladder chart from the list.

4.2.3 Renaming a Ladder Chart

To rename a ladder chart use the Chart Explorer.

1. Click the chart to highlight it, and then click the “Rename” button. Alternatively, right-click the desired chart, and then click “Rename” from the pop-up menu.
2. In the “Rename Chart” dialog box that appears, type the new name. Chart names are limited to 12 characters.
3. Click the “OK” button.

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4.2.4 Copying a Ladder Chart

To copy a chart from the Chart Explorer, follow these steps:

1. Click the chart to highlight it, and then click the “Copy” button. Alternatively, right-click the desired chart, and then click “Copy” from the pop-up menu.
2. In the “Chart Name” dialog box that appears, leave the default new name or type the new name.
3. Click the “OK” button.

Alternatively, from the Ladder Chart Editor, select the “File... Save Ladder Chart As” menu to save the chart with a new name and include it in the project. The old chart remains open and in the project.

4.2.5 Changing Execution Order

The Chart Explorer provides the capability to rearrange chart execution order. To change chart execution order, do the following:

1. From the Chart Explorer, click the name of the desired chart to move.
2. Use the “Up” and “Down” buttons at the bottom of the window to reposition the highlighted chart.

Charts will execute in the order they are arranged. It doesn’t matter if it is a flow chart or ladder chart.

4.2.6 Import Charts

To import charts from another project, use the Chart Explorer.

1. Click the “Import” button to display the “Import Logic Chart” dialog box.

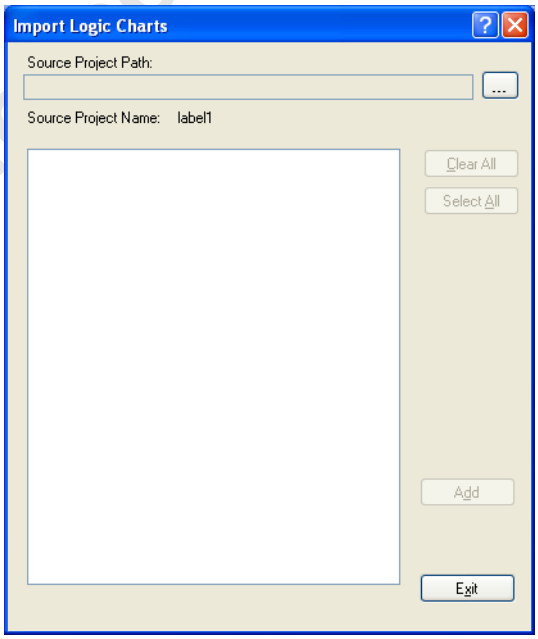

Figure 4-6 The “Import Logic Chart” dialog box

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2. Specify the source project by either typing the full path in the “Source Project Path” field or by clicking the “…” (browse) button.
3. Use the browse dialog box to navigate to the project directory and locate the source project (*.Nano” extension) that contains the charts to import. Once selected, the source project name appears in the “Import Logic Charts” dialog box and all charts in the project appear in the list.

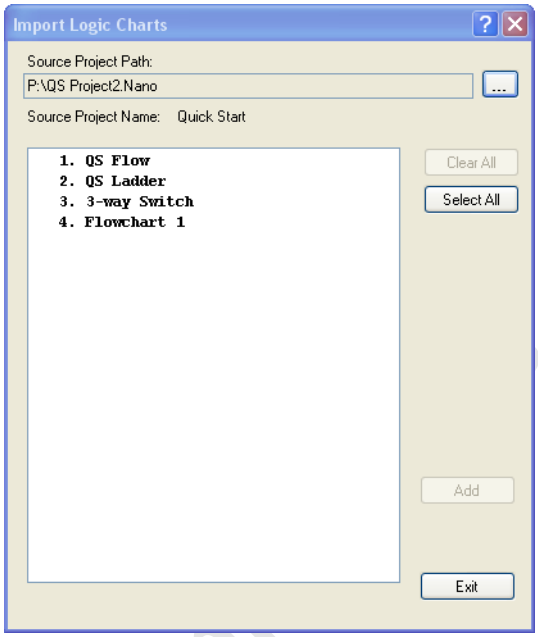

Figure 4-7 The “Import Logic Charts” dialog box with a project selected

4. Select one or more charts in the list using any of the following techniques:
   – Click on a chart.
   – Use standard Windows multiple selection techniques to select multiple charts.
   – Use the “Select All” button to select all charts in the project, and use the “Clear All” button to start over.
5. Click the “Add” button to add the selected charts to the current project.
6. Click the “Exit” button to close the “Import Logic Charts” dialog box.

4.2.7 Deleting a Ladder Chart

To delete a ladder chart, use the Chart Explorer.

1. Click the chart to highlight it, and then click the “Delete” button or press the <Delete> key. Alternatively, right-click the desired chart, and then click “Delete” from the pop-up menu.
2. Click the “Yes” button in the confirmation box to delete the file or click the “No” button to cancel.

The only way to undo deletion of a chart is by closing the project without saving changes. This abandons all changes that were made to the project since the last save.

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4.3 Displaying Multiple Charts

By default, when opening a chart, nanoNavigator maximizes it in the workspace. Switch to other open charts using either the list in the “Window” menu, or by pressing the <Ctrl>+<F6> or <Ctrl>+<Tab> (<Ctrl>+<Shift>+<F6> or <Ctrl>+<Shift>+<Tab> to reverse the order) keys. nanoNavigator also permits maximizing, minimizing, or closing any chart window by using the Window controls in the upper-right corner.

nanoNavigator allows multiple charts to be open simultaneously. This is very useful for copying ladder chart logic from one ladder chart to another.

NOTE:

Different chart types can be opened simultaneously. However, it is not possible to copy content between different chart types. Only content from a flow chart can be copied into a flow chart and only content from a ladder chart can be copied into a ladder chart.

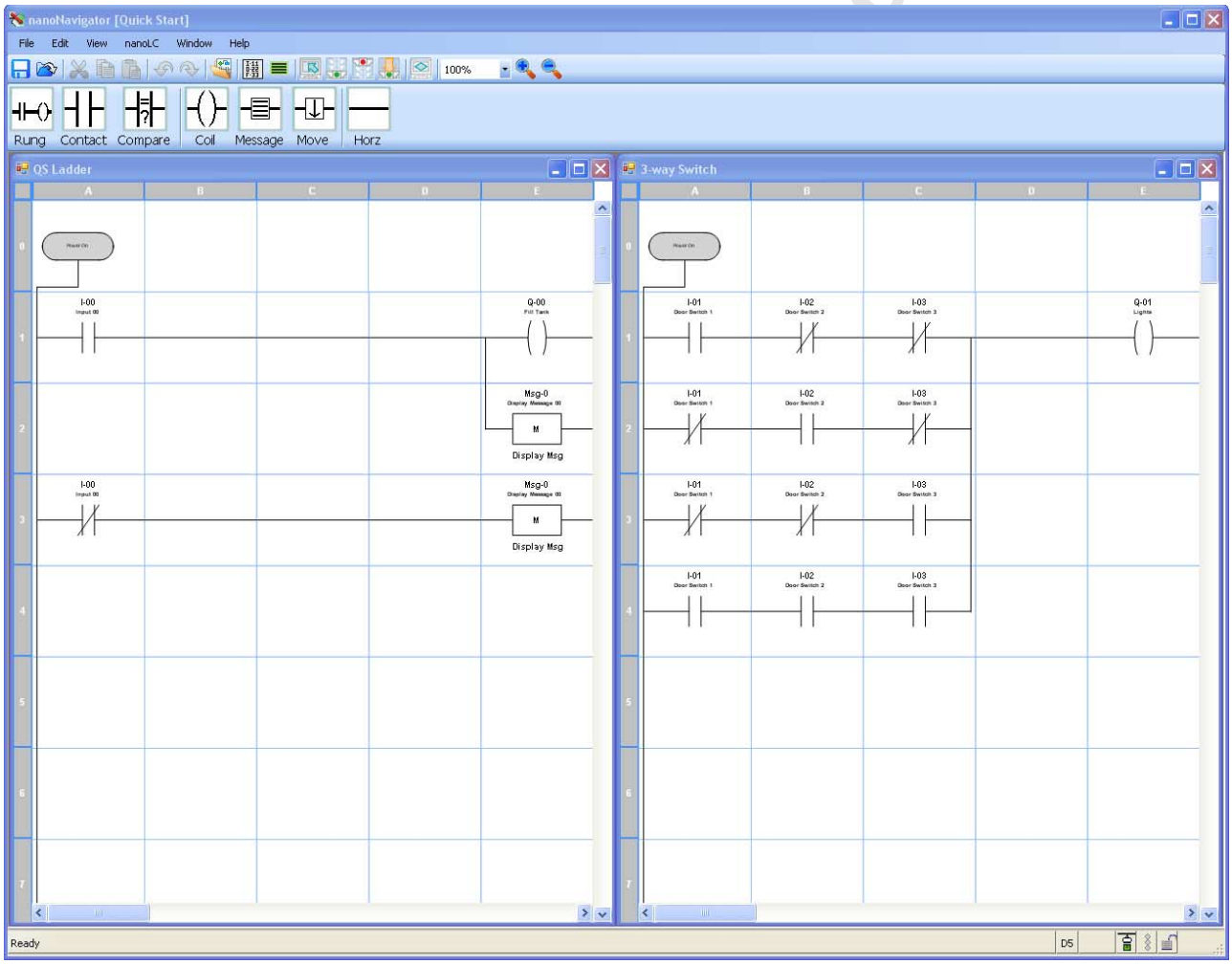

Figure 4-8 Vertically tiled ladder chart windows

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To display more than one chart at a time:

– Select the “Window…Cascade” menu to show all open charts one behind the other, slightly offset.
– Select the “Window…Tile Vertically” menu to display all open charts in a vertical arrangement as shown in Figure 4-8.
– Select the “Window…Tile Horizontal” menu to display all open charts in a horizontal arrangement.

Charts that are minimized are not displayed using the “Window…” commands.

4.4 Editing Ladder Charts

nanoNavigator provides intuitive Windows-style editing capability to move or cut and paste contacts and coils from one grid location to another. Many functions are available with a mouse right-click, or use Main toolbar buttons as described.

4.4.1 Saving Ladder Charts

Select the “File... Save Ladder Chart” menu to save the current ladder chart using the current name (the default is “Ladderchart” followed by a number). Attempting to close a ladder chart after modifying it displays a “Changes Made” dialog box. Click the “Yes” button to save the changes, click the “No” button to close the ladder chart without saving it, or click the “Cancel” button to return to the ladder chart.

To save a copy of the current ladder chart, select the “File... Save Ladder Chart As” menu. This menu selection displays the “Rename Chart” dialog box with a new default name. Either accept the name or type a new name, and then click the “OK” button. This creates a copy of the chart with any modifications and leaves the original chart in the project in the state it was in the last time it was saved.

4.4.2 UnDo and ReDo

nanoNavigator supports an unlimited number of UnDo and ReDo operations. UnDo (or ReDo) operations are performed one at a time in the order they were originally performed. UnDo cancels the last edit operation (for example, deleting a contact from a ladder chart), and restores the chart to its state before the previous operation. After performing an UnDo, a ReDo can be performed. ReDo cancels the previous UnDo operation and restores the chart to its state prior to the UnDo.

nanoNavigator stores UnDo and ReDo operations in separate stacks for each chart. The UnDo stack is cleared (UnDo operations are no longer valid) when:

– a chart is saved
– the project is saved
– a nanoLC is connected
– the project is verified

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The ReDo stack is cleared (ReDo operations are no longer valid) when any edit on the chart is performed other than an UnDo.

Figure 4-9 “Undo” and “Redo” buttons

To perform an UnDo or ReDo operation, do one of the following:

– click the “UnDo” or “ReDo” button on the Main toolbar.
– select the “Edit... UnDo” or “Edit... ReDo” menu.
– press the <Cntrl>+<Z> keys to UnDo or the <Cntrl>+<Shift>+<Z> keys to ReDo.

4.5 Ladder Chart Contacts and Coils

This section describes the various ladder chart coils and contacts, how to place them and create a ladder chart.

To place a new ladder chart element on the page, follow these steps:

1. In the Toolbar, click the button of the desired contact or coil to place.
2. Click in the desired location (cell) on the drawing page.

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4.5.1 Enable Block

Every new ladder chart is created with an Enable block in cell A0. This symbolizes the power source (battery) for the ladder chart and the starting point of the chart. The Enable block is connected to the line on the left side of the chart. This line, or bus, typically represents power. The logic of the chart passes from the left side to the right side, just as power passes from positive to negative. The “return” connection to the Enable block (battery) is not shown.

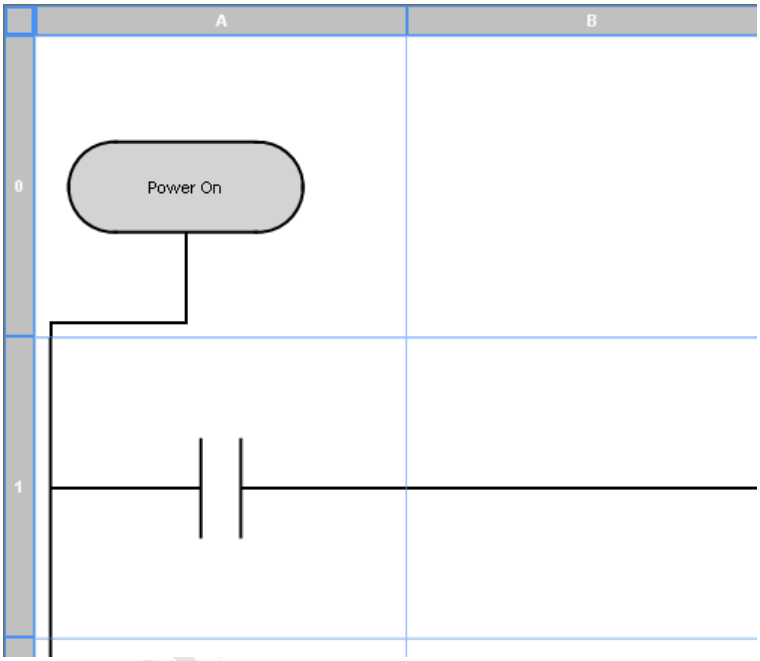

Figure 4-10 Enable block

The Enable block cannot be deleted, copied or moved on the drawing area. It can be configured in the following ways:

– An empty Enable block (no expression created) causes the ladder chart to always run.
– The Enable block is color-coded when running the Simulator or monitoring a connected nanoLine controller. If the block is green, the chart is active. If it’s red, the ladder chart is inactive (another chart is active). If it’s gray, the project is not running.

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Expressions can be added to the Enable block to set conditions for running the chart. To add statements to the expression using logical operators, double-click the element. The result of the expression is either true or false, enabling or disabling the chart.

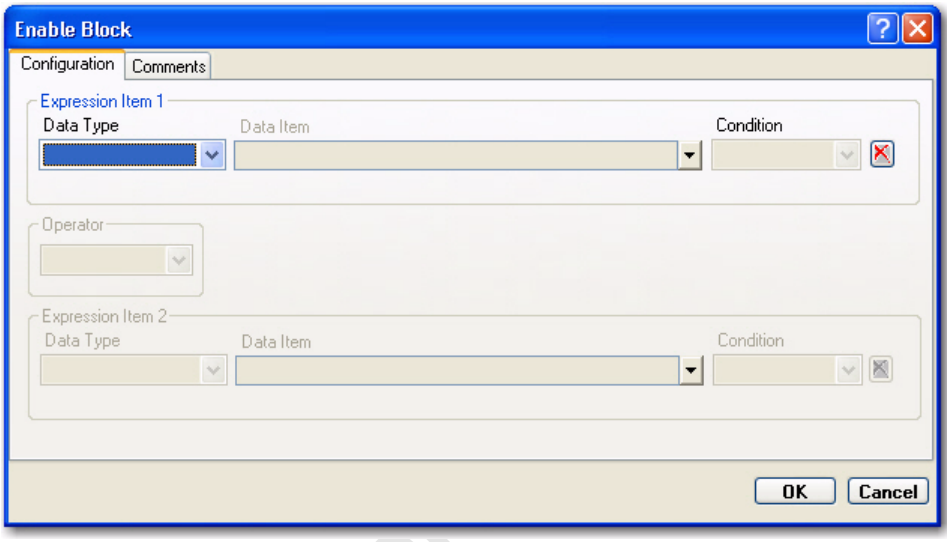

Figure 4-11 The “Enable Block” dialog box

The AND and OR “Operator” in the dialog box permits addition of a second Boolean condition to the expression. AND has greater precedence than OR (in other words AND expressions are evaluated before OR expressions, and then they are evaluated from top-down). nanoLC supports one or two Boolean conditions in an Enable block.

– nanoLC evaluates the Enable element every scan at the time when the chart executes based on the position of the chart in the chart list (see “Changing Execution Order” on page 4-9). The chart only runs if its expression is true at the start of the scan.
– On the first scan or whenever the Enable element expression transitions from FALSE to TRUE, chart execution starts at the Enable element. Otherwise, execution starts where it left off the previous scan.

Table 4-1 defines all possible Enable element combinations. This table shows valid data item types and the conditions that appear in the “Condition” drop-down list. For example, it is possible to test to see if an Input is “ON” or “OFF”.

Table 4-1 Valid Enable Element Expression[1]

Data Item Type	ON	OFF
Input	X	X
Output	X	X
Flag	X	X

1 X=valid

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4.5.2 Rungs

Ladder charts rely on rungs crossing from one bus to the other. A rung is populated with elements, contacts (inputs) and coils (outputs), to create an instruction. The arrangement of the elements can be as parallel or series, normally open or normally closed. The nanoLC processes a ladder chart from left to right and top to bottom with each rung essentially being a separate instruction. As each rung is evaluated, instructions are completed based on the logic of the ladder chart.

When a new ladder chart is created, the first rung is automatically created and includes a contact in cell A1 and a coil in cell E1.

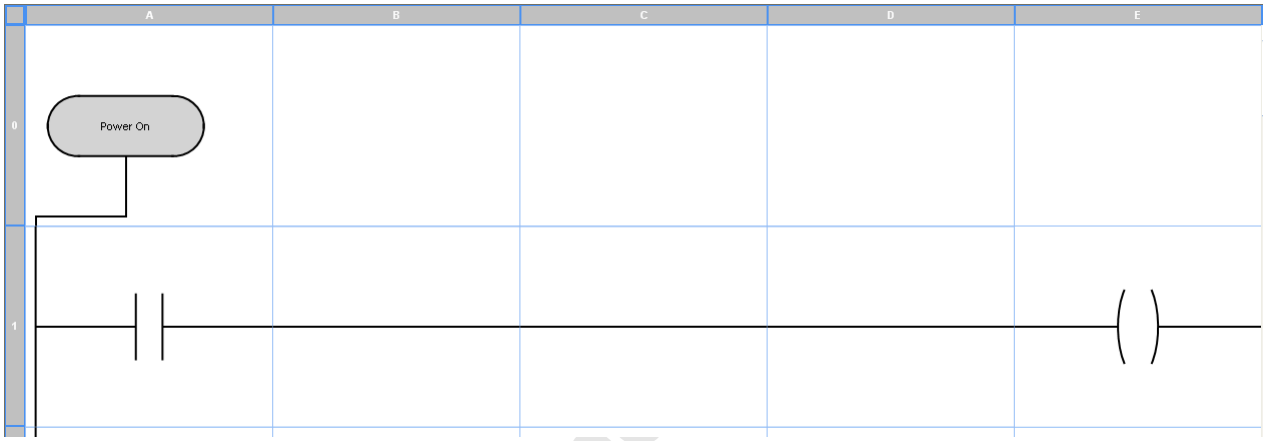

Figure 4-12 New ladder chart with first rung showing default contact and coil

Additional rungs may be added to the chart. Every new rung includes one Contact in column A and one Coil in column E. New rungs may be added anywhere on the chart but they must be contiguous.

To add a new rung:

1. Click the “Rung” button in the Toolbar.
2. Click in the desired location on the grid.
   - Clicking anywhere below the existing rungs will insert a row at the bottom of the ladder chart.
   - Clicking on a row will insert the new rung on that row and move the existing row(s) down. For instance, if rungs exist in rows 1 through 4, clicking on row 3 will move the rung in row 3 to row 4, and the rung in row 4 to row 5. The new rung is in row 3.

A second method to add rungs is available. Right-click on the row label and click “Insert Rung” on the menu.

To delete a rung, right-click on the row header and click “Delete Rung” on the menu.

Empty rows can also be added to the grid. Right-click on the row header and then click either “Insert Row Before” or Insert Row After” on the menu.

It is not possible to add parallel branches to an existing rung if another rung is directly below it. A blank row must be added first.

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The various types of contacts and coils can be added to a rung. To place elements on a page:

1. In the Toolbar, click the button of the desired element.
2. Click in the desired location on an existing rung.

Horz Button

Contacts can be placed in columns A through D and coils can be placed in column E.

To remove an element from a rung:

1. In the Element toolbar, click the “Horz” button.
2. Click the desired element to remove.

A rung must contain a contact in column A and a coil in column E. It is not possible to delete these elements from a rung.

Contact Button

4.5.3 Decision Contact

A Decision Contact is an element in a rung that makes or breaks a circuit, or rung. The Decision Contact may be external, such as a switch connected to a physical input or keypad key from the Operator Panel, or internal, such as a flag, timer or output. A Decision Contact is configured to a default position (either normally closed or normally open). By combining various Decision Contacts in series and parallel arrangements in a rung, the logic of the rung becomes either True or False, causing the coil in column E to be either True or False.

Decision Contact elements can be placed in either parallel or series arrangements on a rung. After clicking the “Decision Contact” button on the Toolbar, the pointer changes as it hovers over different cells to indicate how the element will be connected to the rung.

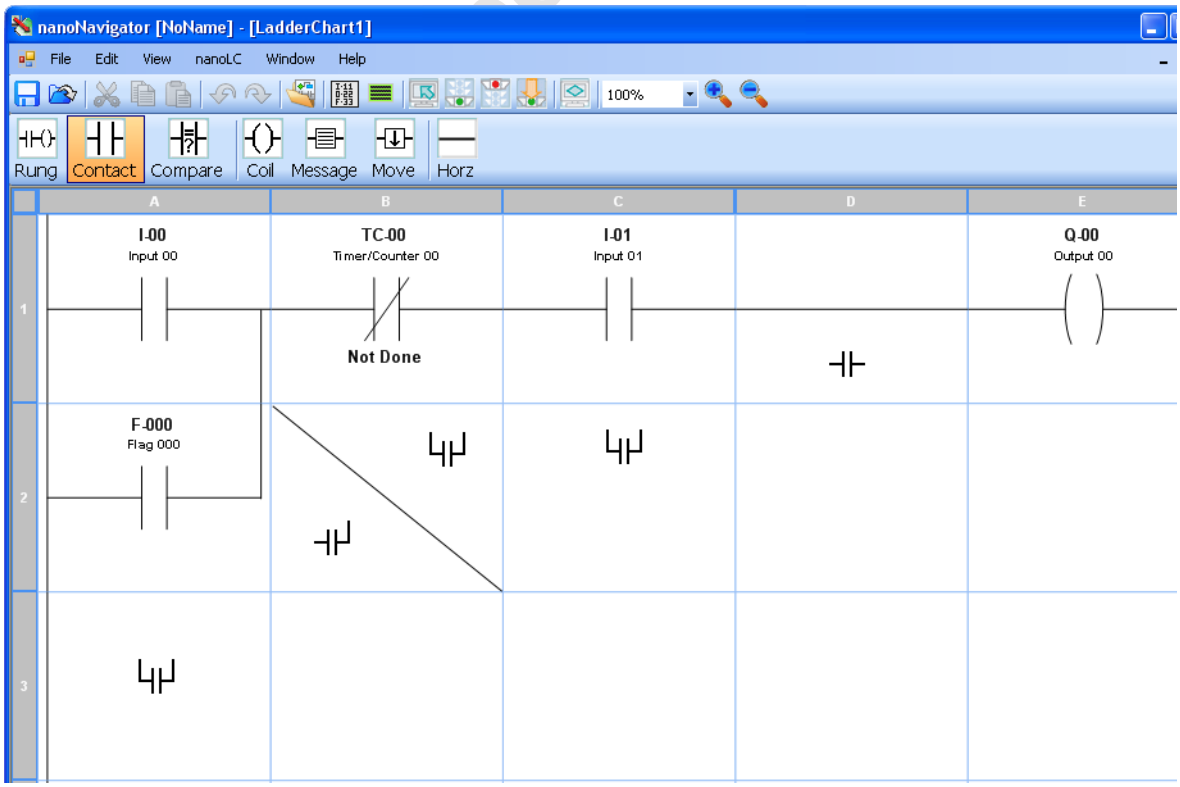

Figure 4-13 Placing Decision Contacts in different arrangements

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Figure 4-13 shows the cursor in different positions in the Ladder Chart Editor.

- In cell D1, the cursor indicates the contact will be inserted in series.
- In cell A3, the cursor indicates the contact will be inserted in parallel with the Decision Contact in cell A2.
- In cell C2, the cursor indicates the contact will be inserted in parallel with the Decision Contact in cell C1.
- Cell B2 is diagonally “divided” into two halves.
  - If the mouse is clicked when the cursor is in the lower left, the Decision Contact will be in series with the relay in cell A2. Both elements row 2 will be in parallel with the elements in cells A1 and A2.
  - If the mouse is clicked when the cursor is in the upper right, the Decision Contact will be in parallel with the element in cell B2 (and not in series with the element in cell A2).

To configure a Decision Contact, double-click the Decision Contact in the workspace. This displays the “Decision Contact” dialog box. The Decision Contact is configured by selecting the data type, data item and what the condition of the data item should be to make it true. The configuration options for the different data item types are shown in Table 4-2.

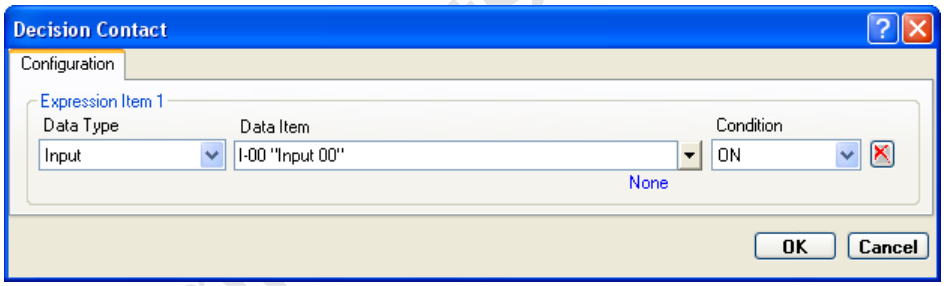

Figure 4-14 “Decision Contact” dialog box

If all the conditions are met, the expression is considered true. If the conditions in the expression are not met, the expression is considered false.

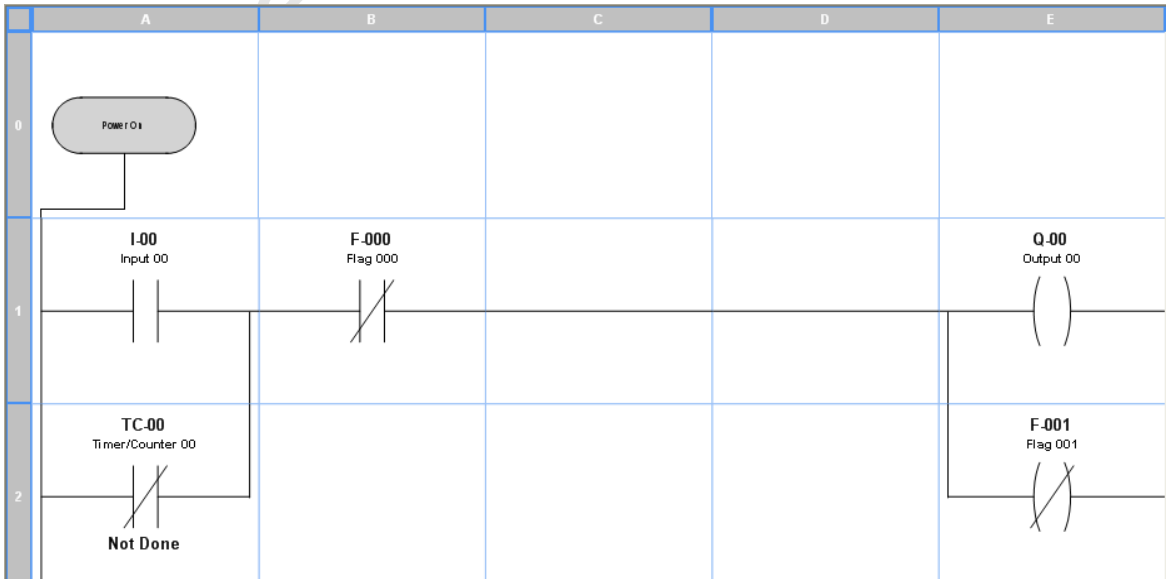

Figure 4-15 Decision Contact symbols

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When the “Decision Contact” dialog box is closed, the symbol changes to represent the default condition of the element. If the default condition is ON, the symbol appears as normally open contacts. If the configured condition is OFF, the symbol appears as normally closed contacts. With Timer/Counter data types using the mSec or HMS mode, the “Condition” field allows selection of Done and Running, indicated by normally open contacts, or Not Done and Not Running, indicated by normally closed contacts (Counters are limited to Done and Not Done conditions).

If selecting an unconfigured Timer/Counter, a dialog box opens with a drop-down list that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or Duration (x.xxx Sec.)”.

In addition to the symbol representing the condition, the default condition is written below the symbol. The Data Item Type and ID monitored in the cell is displayed.

Decision Contact Summary

Table 4-2 defines all possible Decision Contact combinations.

Table 4-2 Valid Comparisons in a Decision Contact[1]

		Bits		Timer/ Counter				HS Counter			
Data Item Type	**Mode**	**On**	**Off**	**Done**	**Not Done**	**Running**	**Not Running**	**Done**	**Not Done**	**Enabled**	**Disabled**
Input		X	X								
Output		X	X								
Flag		X	X								
Key pad entry		X	X								
Timer/Counter	HMS			X	X	X	X				
	mSec			X	X	X	X				
	Counts			X	X						
HS Counter								X	X	X	X

[1] X=valid

Compare Contact Button

4.5.4 Compare Contact

A Compare Contact compares two numerical data items. The types of comparisons available are less than (<), equal to (=), greater than (>), greater than or equal to (>=), less than or equal to (<=), and IsEven (checks for an even number). There are also special direct time and date comparison operations for date, time, day of week, day of month, and day of year. An expression is created and the program evaluates the two data items based on the comparison operator.

Compare Contact elements can be placed in either parallel or series arrangements on a rung. After clicking the “Compare” button on the Toolbar, the pointer changes as it hovers over different cells to indicate how the element will be connected to the rung. This function works using the same method as the Decision Contacts (See Figure 4-15).

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To configure a Compare Contact, double-click the Compare Contact in the workspace. This displays the “Compare Contact” dialog box. The expression is created by selecting the data type and specific data item for the First Item, the Comparison Operator, and the data type and specific data item of the Second Item. When the comparison is evaluated, the Compare Contact becomes logically true if the expression is true. The Compare Contact becomes logically false if the expression is not true.

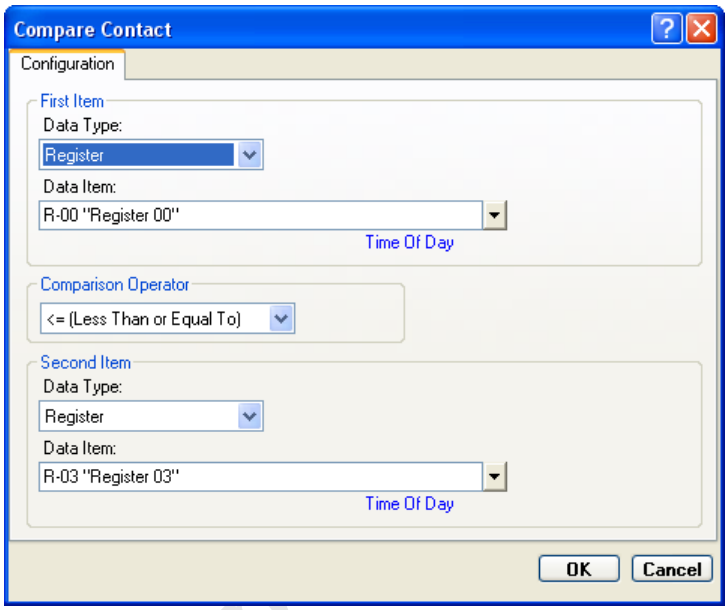

Figure 4-16 “Ladder Compare Contact” dialog box

When using a constant in the expression, the variable operand must be the First Item and the constant must be the Second Item.

Both Registers and Timer/Counters have subtypes. The default subtype of both is “Unconfigured.” If selecting an unconfigured type for the first operand, nanoNavigator prompts for selection of the type. The subtype of the second operand must match the subtype of the first operand. The drop-down list only shows operands with matching or unconfigured subtypes. If selecting an unconfigured item, nanoNavigator permits changing the subtype to match the type of the first operand.

When comparing “Current Date” or “Current Time” or a register with a subtype of “Date” or “Time of Day”, choose which components of the date or time to include in the comparison. For instance, to perform a date compare between the day and month, ignore the year. Likewise, to perform a time compare between minutes, ignore the hours and seconds.

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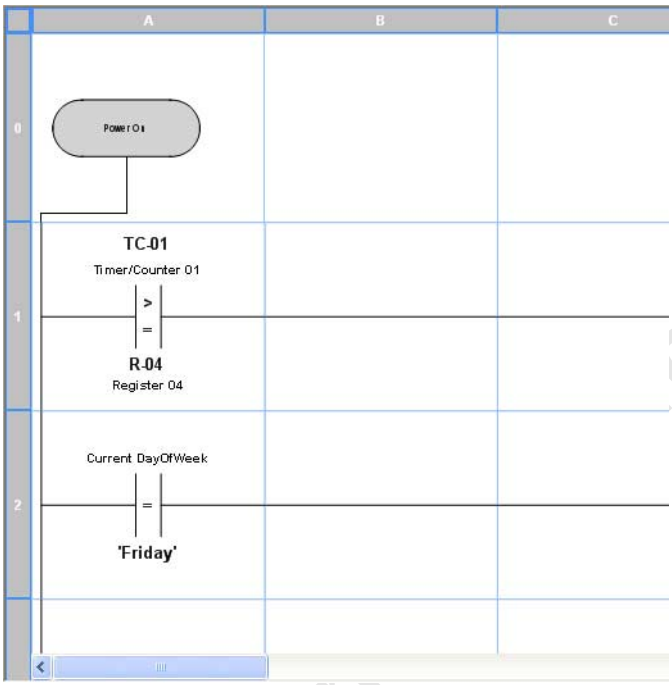

Figure 4-17 Compare Contact symbols

With Timer/Counter data types using the mSec or HMS mode, the “Condition” field allows selection of Done and Running, indicated as a normally open contact, or Not Done and Not Running, indicated as a normally closed contact (Counters are limited to Done and Not Done conditions).

If selecting an unconfigured Timer/Counter, a dialog box opens with a drop-down list that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or Duration (x.xxx Sec.)”.

When the “Compare Contact” dialog box is closed, the symbol changes to show the two items being compared, one above the symbol, the other below. If one of the items is a Data Item, the Type and ID are displayed. If the item is a constant, the constant is displayed. The operator used to compare the two items is displayed within the symbol.

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Compare Contact Summary

Table 4-3 defines all possible Compare Contact combinations.

Table 4-3 Valid Comparisons in a Compare Contact[1]

		Data Item Type							Constant Value									
Data Item Type	**Sub-type**	**Integer**	**Date**	**Time**	**DoW**	**HMS**	**mSec**		**Integer**	**Date**	**Time**	**DoW**	**HMS**	**mSec**		**IsEven**		**Display Format**
Register	Integer	X							X							X		xxxxxxxx
	Date		X							X								dd/mm/yy
	Time			X							X							hh:mm:ss
	DoW				X							X						Sun-Sat
	HMS					X							X					hh:mm:ss
	mSec						X							X				xxxx.xxx
Timer/Counter	Counts	X							X							X		xxxxxxxx
	HMS					X							X					hh:mm:ss
	mSec						X							X				xxxx.xxx
Analog In		X							X							X		xxxxxxxx
Analog Out		X							X							X		xxxxxxxx
HS Counter		X							X							X		xxxxxxxx
Message Input	Integer	X							X							X		xxxxxxxx
	Date		X							X								dd/mm/yy
	Time			X							X							hh:mm:ss
	DoW				X							X						Sun-Sat
	HMS					X							X					hh:mm:ss
	mSec						X							X				xxxx.xxx
Current Date			X							X								dd/mm/yy
Current Time				X							X							hh:mm:ss
Day of Week					X							X						Sun-Sat
Day of Month		X							X									xx
Day of Year		X							X									xxx
	Notes: DoW is Day of the Week																	

[1] X=valid

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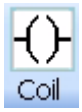

Coil Button

4.5.5 Control Coil

A Control Coil represents the logical result of a rung. As the elements on a rung are evaluated, a Control Coil defines the result, or action. If all the elements in the rung are determined to be True, the Control Coil becomes True and causes an action. If any of the elements on the rung are False, the Control Coil becomes False and the action does not occur. A maximum of four Control Coils can be placed in parallel in a single rung. They are always located in column E at the end of a rung.

A Control Coil may be a physical output, such as a lamp, or an internal output, such as a flag or timer/counter that is used elsewhere in the chart.

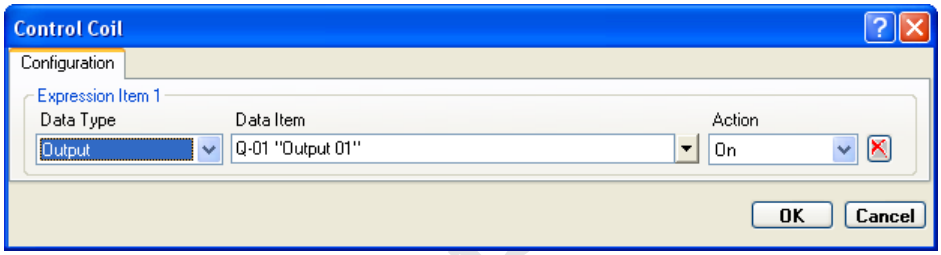

Figure 4-18 “Control Coil” dialog box

To configure a Control Coil, double-click the Control Coil in the workspace. This displays the “Control Coil” dialog box. The Control Coil is configured by selecting the data type, data item and what the resulting action of the data item should be. When all the previous elements in the rung are met, the Rung is considered True and the condition is set as specified in the “Action” field. If the conditions in the expression are not met, the expression is considered False and the action is not performed.

The On and Off Actions are momentary and will remain in those conditions as long as the contact logic before it remains true or false. The Set Action latches the coil until elsewhere in the program a Reset is issued or an Off Action is issued.

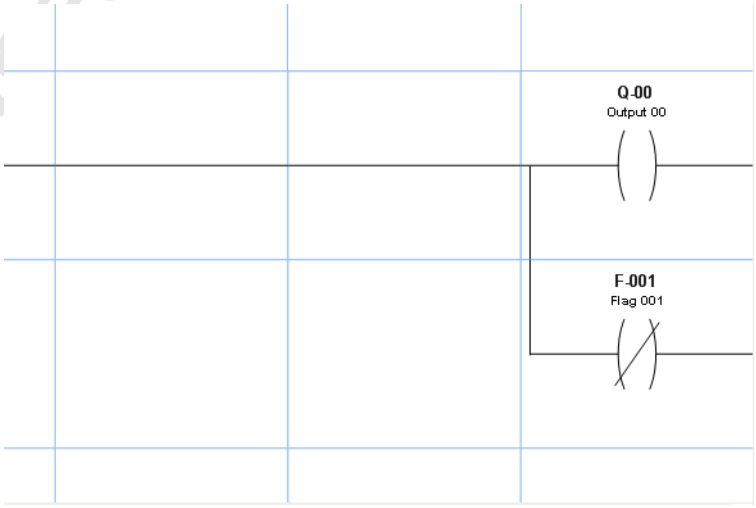

Figure 4-19 Control Coil symbols

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When the “Control Coil” dialog box is closed, the symbol changes to represent the desired action of the element. If the configured condition is On, Set or Reset, the symbol appears as normally open. If the configured condition is Off, the symbol appears as normally closed. All Timer/Counter data types appear as normally open.

If selecting an unconfigured Timer/Counter, a dialog box opens with a drop-down list that permits configuration of the Timer/Counter as a “Counter”, “Duration (HMS)”, or Duration (x.xxx Sec.)”.

In addition to the symbol representing the desired action, the desired action is written below the symbol and the Data Item Type and ID being changed is written above the symbol.

Control Coil Summary

Table 4-2 defines all possible Control Coil combinations.

Table 4-4 Valid Comparisons in a Control Coil[1]

		Bits						Timer/ Counter						
Data Item Type	**Mode**	**On**	**Off**	**Set**	**Reset**	**Pulse**	**Flash**	**Restart**	**Start**	**Stop**	**Reset**	**Increase**	**Decrease**	**Reset**
Output		X	X	X	X	X	X							
Flag		X	X	X	X									
Timer/Counter	HMS							X	X	X	X			
	mSec							X	X	X	X			
	Counts											X	X	X

1 X=valid

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Message Coil Button

4.5.6 Message Coil

When configured with the optional Operator Panel, the nanoLC can display messages to the user. Message Coils can contain static text, dynamic values from any data item, and data entry requests. To configure a Message Coil, double-click the Message Coil in the workspace. This displays the Configuration page of the “Message Coil” dialog box.

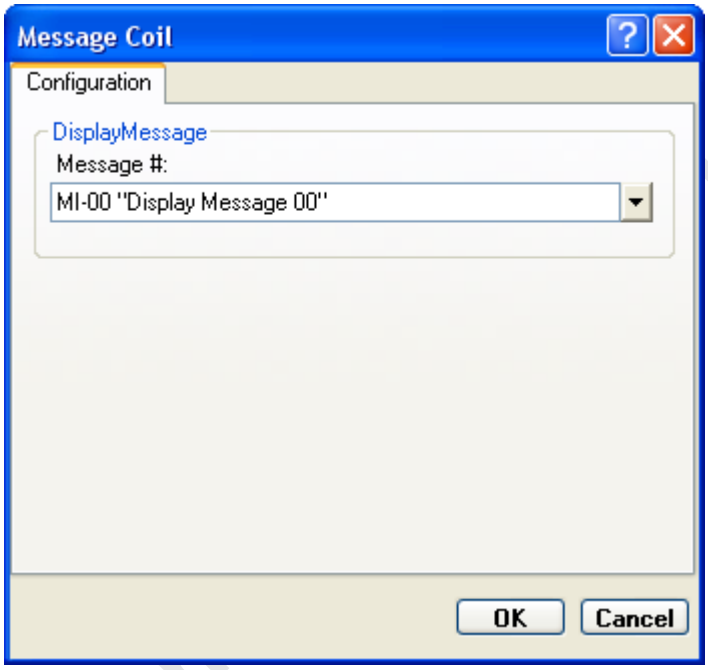

Figure 4-20 “Message Coil” dialog box

The “Message #” drop-down list allows selection of a message number (from 0 to 31). The Message Editor permits entry or modification of the message associated with that message number (see “Using the Message Editor” on page 4-28).

Only configured messages appear in the “Message #” drop-down list. They must be “created” in the Message Editor before they appear in the list.

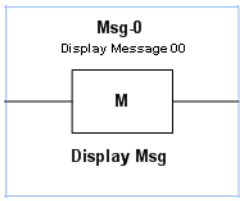

Figure 4-21 Message Coil symbol

When the Message is selected and the “Message Coil” dialog box closed, the Message Box symbol appears. In addition to the symbol, the Data Item Type and ID is written above the symbol and the text **Display Msg** below the symbol.

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Obtaining User Input

As defined in “Inserting Data Entry Items” on page 4-29, messages can include data variables that prompt for user input. As the operator enters data through the keypad on the Operator Panel, the Operator Panel processor validates the input data according to the data type specified. Once the operator completes data entry and presses the “OK” key, the Operator Panel passes the input to the chart and sets the “Message Input Ready” key for one scan cycle.

Charts that require operator input must continue to look for the “Message Input Ready” key or some overriding condition that would inhibit data from being entered on every scan after sending the message requesting input.

With a Ladder Chart, a latch mechanism should be incorporated to prevent the logic from requesting data entry each scan. Figure provides a typical example of a rung incorporating a Message coil that is logically true for a single scan.

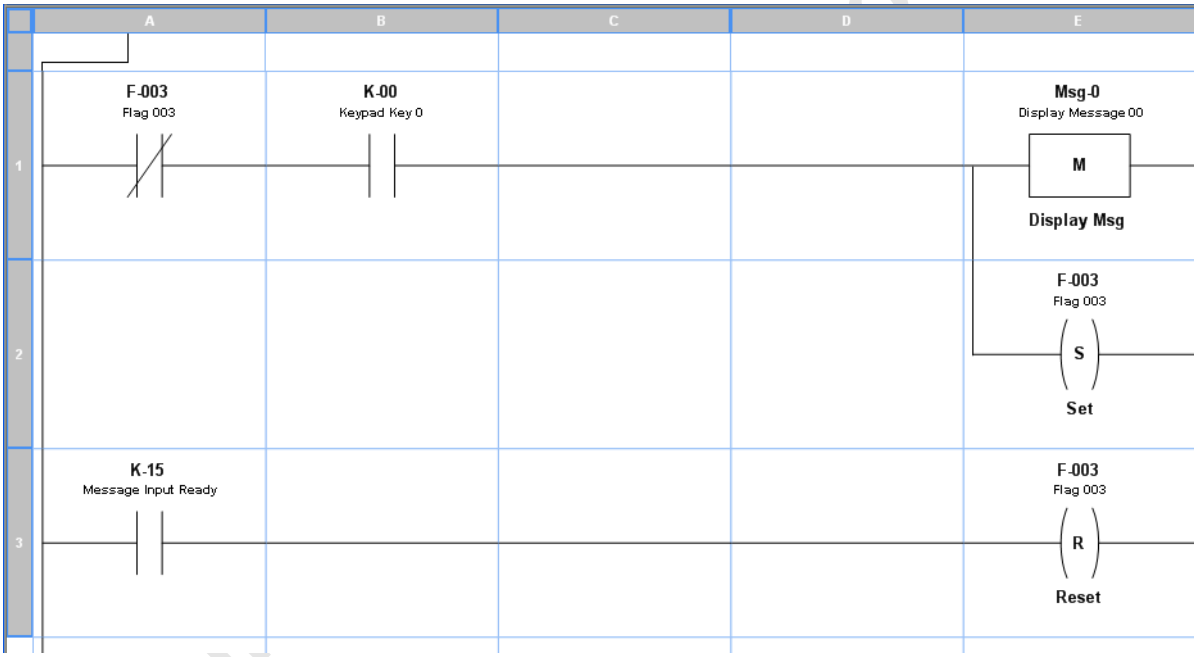

Figure 4-22 Message coil latching logic example

In the example, once Msg-0 is displayed, F-003 is set to make rung 1 logically false. Once the user presses the <OK> key on the nanoLC, F-003 is reset, allowing the message to display again, provided the remainder of the project logic is true.

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4.5.7 Move Coil

Move Coil Button

The Move Coil transfers data from one location to another. Doing a move from one data item to another moves (copies) the data of the first data item into the second data item. The value of the first data item is preserved.

The “Move Coil” dialog box defines the “From” and “To” data fields. After selecting the “Data Type”, the “Data Item” drop-down list displays only those data items for the type selected.

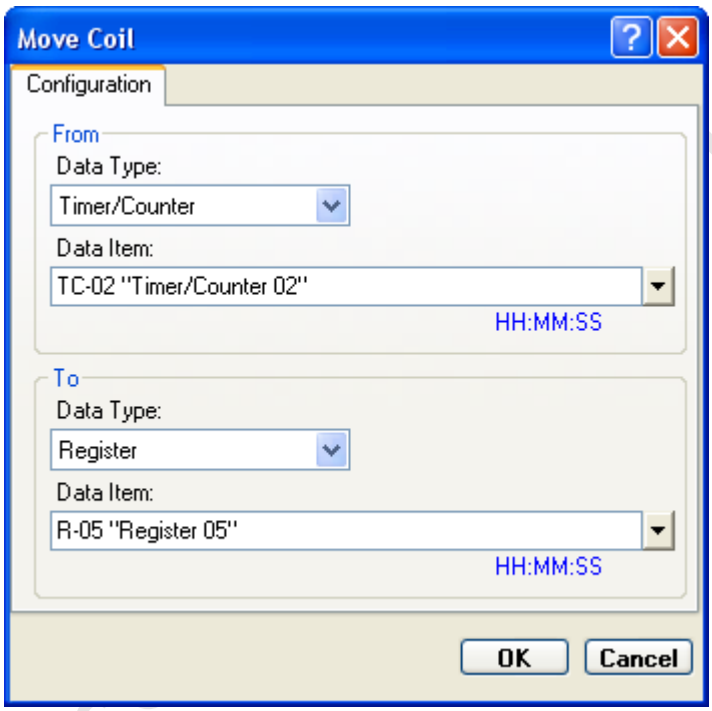

Figure 4-23 “Move Coil” dialog box

The Move Coil symbol is displayed as a rectangle with an arrow with the Data Item Type and ID being moved displayed above the symbol and the location it is being moved to displayed below the symbol.

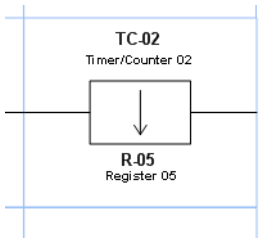

Figure 4-24 Move Coil symbol

For more information on how the Move Coil performs powerful data manipulations, refer to “Using the Move Function” on page 5-13.

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4.6 Using the Message Editor

The Message Editor permits definition of up to 32 four-line messages to use during project execution. Each line can have up to 20 characters, and lines can contain any combination of static text, data item output, and user-requested input.

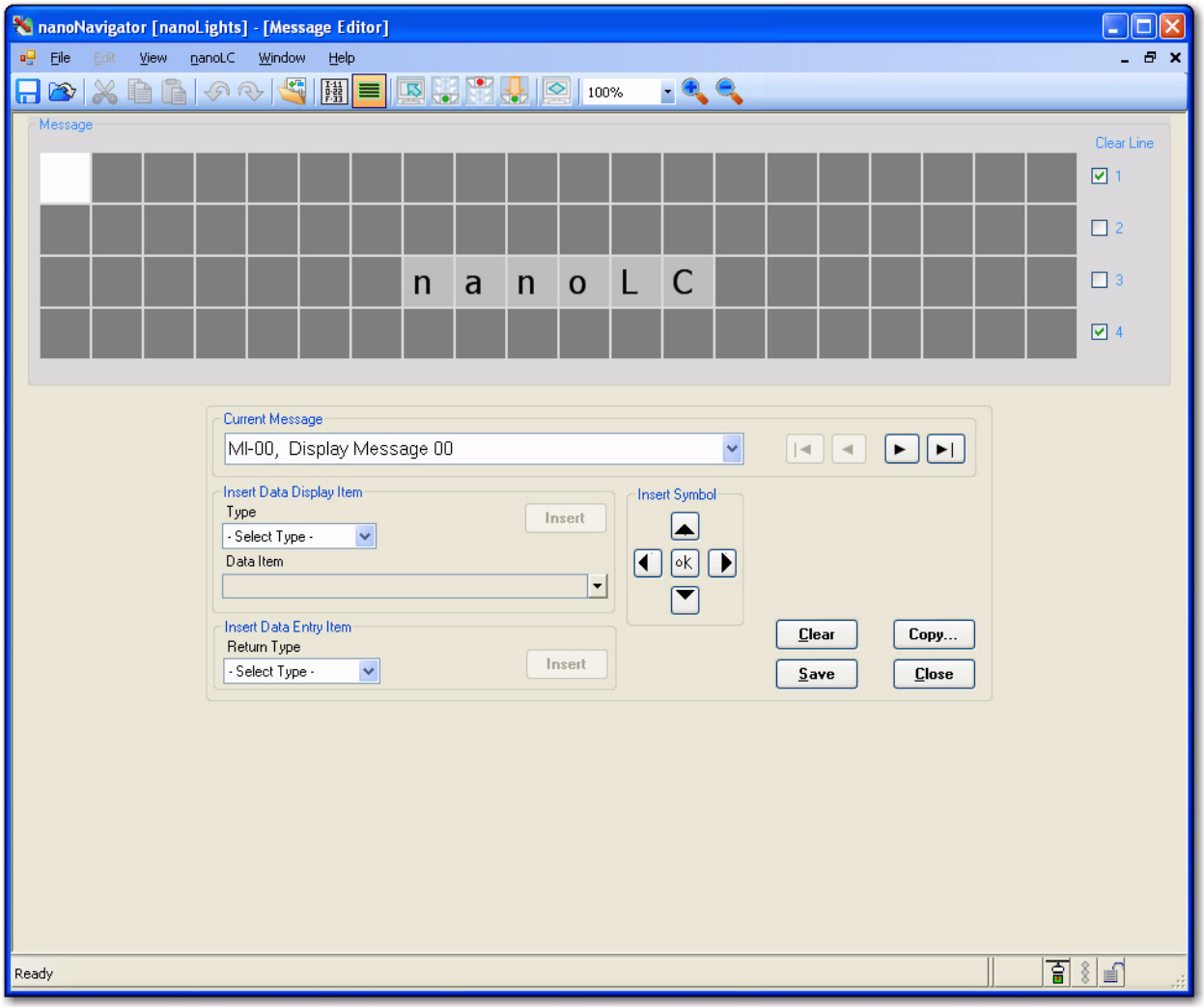

Figure 4-25 Use the Message Editor to define and edit messages in a project

4.6.1 Displaying the Message Editor

Edit Messages Button

Click the “Edit Messages” button in the Main toolbar, or select the “View... Message Editor” menu to display the Message Editor in the nanoNavigator workspace. Once open, the Message Editor is like any other window. Display the Message Editor by selecting it from the “Windows” menu, selecting it again from the “View” menu, or pressing <Ctrl>+<F6> or <Ctrl>+<Shift>+<F6> until it appears on top. When using “Windows... Cascade” or one of the “Tile” options with the Message Editor open, the Message Editor appears along with all open charts.

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4.6.2 Creating and Editing Messages

To create or edit a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to create or edit from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Enter any static text, data display items, data entry items, and/or symbols in the fields.

The nanoLC does not clear any message cells that aren’t explicitly overwritten. To ensure that an old message is cleared before writing a new one, leave the “Clear Line” check box selected (selected by default) for the line(s) to clear prior to displaying new text.

The symbols that appear in the “Insert Symbols” list correspond to special keys that are available on the nanoLC.

4. Click the “Save” button to save the message.
5. Click the “Close” button to close the Message Editor.

Inserting Data Display Items

To display a data item, use the “Insert Data Display Item” group as follows:

1. Select a cell of the message.
2. Select the data item “Type” from the drop-down list.
3. Select the data item from the “Data Item” drop-down list.
4. Click the “Insert” button to insert the data display item in the message.

Inserting Data Entry Items

To have the user enter a data item, use the “Insert Data Entry Item” group as follows:

1. Select a cell of the message.
2. Select the data item “Return Type” from the drop-down list.
3. Select the data item from the “Data Item” drop-down list.
4. Click the “Insert” button to insert the data entry item in the message.

4.6.3 Copying Messages

To copy a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to copy from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Click the “Copy...” button. This displays the “Copy Message” dialog box.
4. Enter a message number in the “Message #” field or use the up/down buttons to select a message number. The number entered is the destination for the copy operation.

An asterisk (*) in the number field indicates the message has been configured previously.

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5. Click the “OK” button. The copy operation executes immediately unless the destination message already has text or fields. In that case, a warning message appears before the operation completes.

4.6.4 Clearing Messages

To clear a message, follow these steps:

1. Select the “View... Message Editor” menu or click the “Edit Messages” button on the Main toolbar to display the Message Editor.
2. Select the message to clear from the “Current Message” drop-down list. This displays the current message in the four lines of the “Message” group at the top of the window.
3. Click the “Clear” button. This displays a confirmation dialog box.
4. Click the “Yes” button to clear the message.

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Section 5

This section provides information about:

- Data items
- Timers and counters
- Move blocks
- Analog values

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5 Data Operations

This chapter discusses how to use variables and constants in nanoNavigator. It begins with an overview of the available data item types and includes details on available data operations.

5.1 Using the Data Item Editor

Data items are a central part of every project. They are the variables that contain project data. Data items have IDs that correspond to the IDs on a nanoLC. In nanoNavigator, data items also have names assigned as part of a project. The data item names assigned in nanoNavigator do not download to the nanoLC with the project. However, whenever nanoNavigator connects to a nanoLC, nanoNavigator uses the version of the project on the PC to view and verify a running nanoLC project (see “Running Projects and Controlling the nanoLC” on page 6-3). nanoNavigator contains the tools for viewing all parts of the project, including the Data Item Editor.

Edit Data Items Button

5.1.1 Displaying the Data Item Editor

To display the Data Item Editor in the nanoNavigator workspace, click the “Edit Data Items” button on the Main toolbar, or select the “View... Data Item Editor” menu. Once it is open, the Data Item Editor is like any other window. Display the Data Item Editor by selecting it from the “Windows” menu, selecting it again from the “View” menu, or pressing <Ctrl>+<F6> or <Ctrl>+<Shift>+<F6> until it appears on top. With “Windows... Cascade” selected or one of the “Tile” options with the Data Item Editor open, the Data Item Editor appears along with all open charts.

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5.1.2 Data Item Editor

The initial view of the Data Item Editor lists the data item types in nanoNavigator (see Figure 5-1). Each data item type is preceded by a plus button. Click the “+” button to view the defined data items of that type.

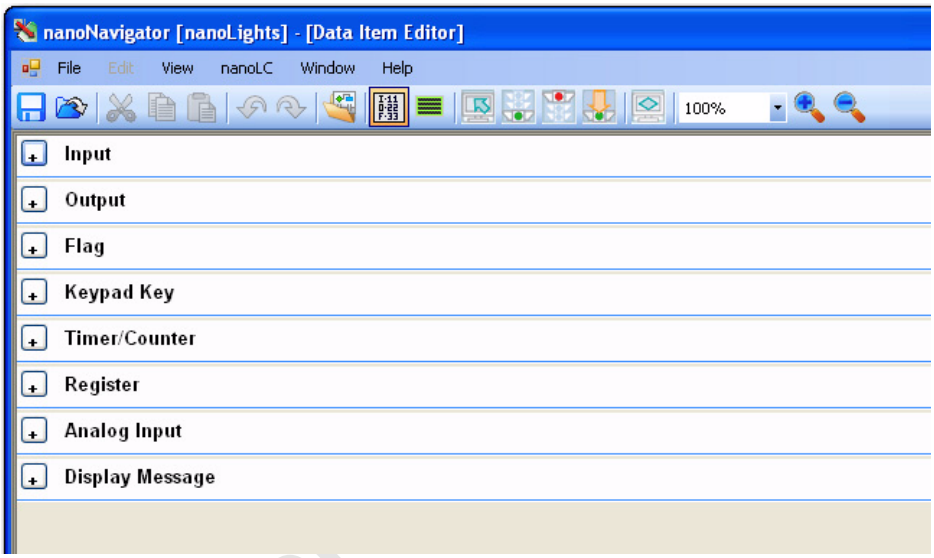

Figure 5-1 The Data Item Editor initially displays all available data types

The Data Item Editor displays the defined data items of one or more types by clicking the plus button in front of the type heading. If necessary, use the scroll bar to view the entire list of data types and/or data items.

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In nanoNavigator, all data items are pre-defined based on the configuration of the nanoLC.

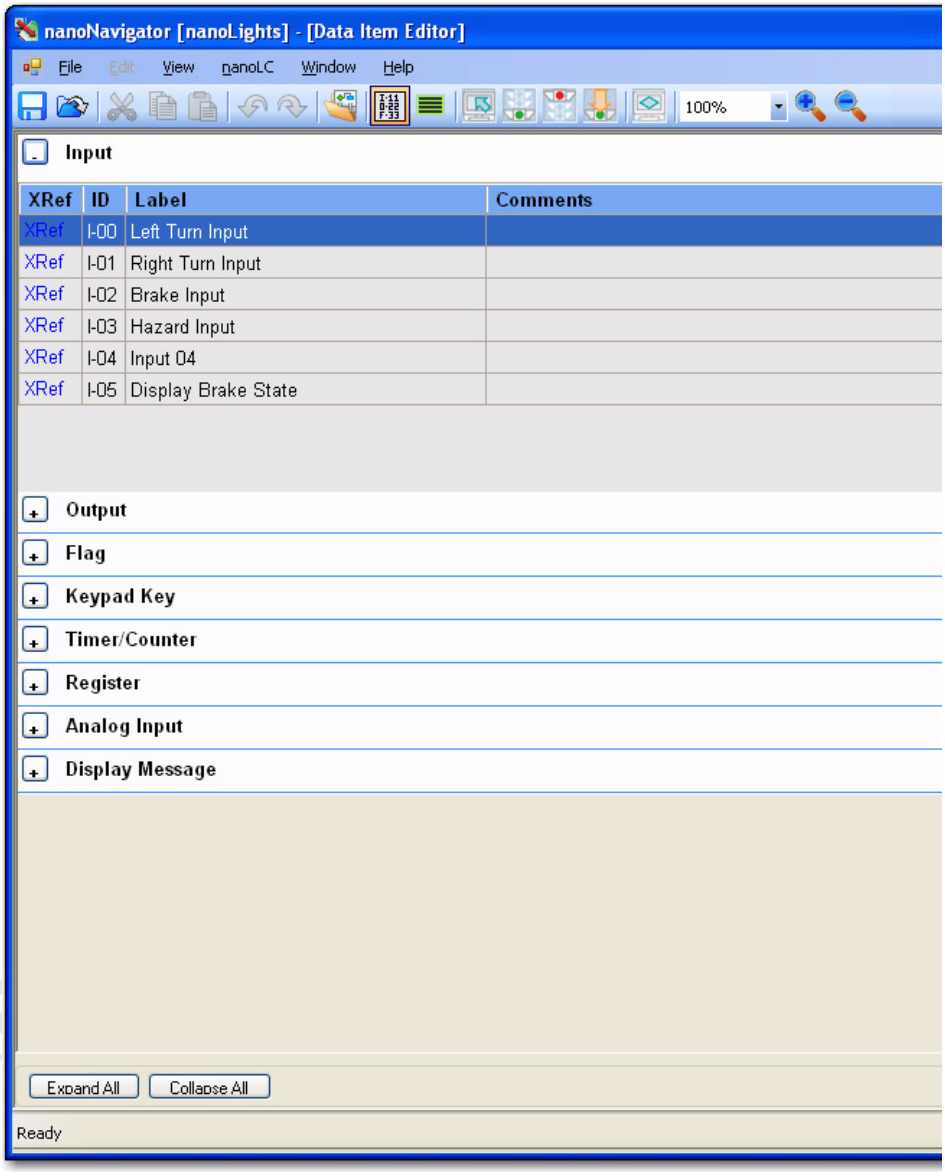

Figure 5-2 The Data Item Editor with an opened data type

5.1.3 Data Item Types

For a list of data item types available in nanoNavigator, see “Data Type Descriptions” on page 5-7. These data item types appear as headings in the Data Item Editor. To view available data items for each type, click the + (plus) button in front of the type heading (see Figure 5-2).

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New projects have all available data items listed. Data items have an ID that corresponds to their ID on the nanoLC, and they have a default name, which is modifiable. Data item names can be up to 30 characters long. Long data item names are split when they appear in a chart. The data item name does not get downloaded to the nanoLC.

When uploading a project from a nanoLC, nanoNavigator resets data item names to their default names if the project isn't available on the PC because data item names aren't stored on the nanoLC.

5.1.4 Editing Data Item Grid Entries

The Data Item grid permits modification of default data item names and, depending on the data item type, permits entry of a description, indicates that a data item is retentive, and specifies an initial value. For Timer/Counter and Register data items, specify the type, and for Timer/Counters, specify the preset.

5.1.5 Using Cross-Reference

Each data item row in the Data Item Editor has an "XRef" link on the left side of the line. When the link is clicked, nanoNavigator searches all charts and messages for references to the data item, and then it displays the "Project Information... CrossReference" tab (see Figure 5-3).

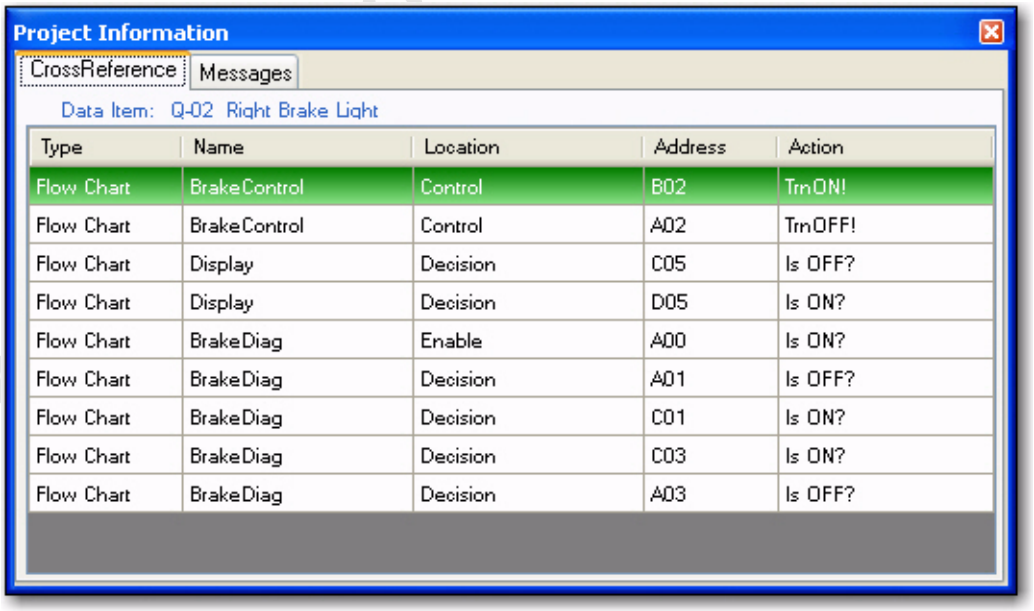

Figure 5-3 The "Project Information... CrossReference" tab

The rows of the "CrossReference" tab list all occurrences of the data item in the project. The columns provide the following information:

– Type: Either "Flow Chart," "Ladder Chart" or "Message"
– Name: The name of the chart or the message number
– Location: The type of chart element

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– Address: The cell number of the element
– Action: The action taken in the element on the data item

Double-click anywhere in a row to display the chart or message and the element containing the data item.

5.2 Data Type Descriptions

There are ten data item types in nanoNavigator. Depending on the nanoLC configuration, some data item types may not be present in the Data Item Editor.

Analog Input

Present if available in the nanoLC. Use analog input to monitor voltages or values. The Analog Input data item is a 16-bit number that is proportional to the actual voltage or current present at the input pin. There are a maximum of 8 analog inputs. The number available depends on the configuration of the nanoLC. For more information on analog inputs, see “Handling Analog Values” on page 5-16.

Analog Output

Present if available in the nanoLC. Use analog outputs to set voltages or values. The Analog Output data item is a 16-bit number that is proportional to the actual voltage or current output. There are a maximum of 8 analog outputs. The number available depends on the nanoLC configuration selected. For more information on analog outputs, see “Handling Analog Values” on page 5-16.

Display Message

The Message data type provides support for the optional display on the nanoLC. There are up to 32 messages with each message containing up to four lines of 20 characters.

Flag

Flags are single-bit variables that have a value of either 0 or 1. These are for general use to store a Boolean (TRUE/FALSE) variable. Although these are single-bit variables, they are not associated with discrete I/O points. There are a total of 64 binary user-definable flags. These flags are available for general project use. They can have an initial value (set=1) and may be retentive. In addition, there are System Flags that provide Runtime status and control (see Appendix B, “Technical Appendix – System Flags”).

Input

Digital inputs are either ON or OFF (0 or 1). There are a maximum of 32 digital inputs. The number available depends on the nanoLC configuration selected.

High-Speed Counter

Present if available in the nanoLC and configured. There are a maximum of two high-speed counters. If present, these may be enabled or disabled by project.

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Keypad Key

The Keypad Key data type provides single-bit (0-1) input that corresponds to the Operator Panel keys on the nanoLC. One or TRUE values indicate that a key is being pressed. There are a total of 15 keys (0-9, four arrow keys, an “OK”) that are available only if the optional Operator Panel is present on the nanoLC. There is a sixteenth key data item for “Message Input Ready”.

Output

An Output data item is a single-bit (0 or 1) for use with discrete output points for the I/O sub-system. A maximum of 32 output points are available.

Register

There are a total of 32 registers. Configurable as Unconfigured, Integer, Date, Time of Day, Duration (HH:MM:SS or msec). Registers can have an initial value and may be retentive.

Timer/Counter

The Counter data item is configured as a Timer/Counter with a “Counter” subtype. Counters range in value from 0 to 99,999,999. Timer/Counter data items count upward once per millisecond. The Timer/Counter value (accumulator) is accessible to charts. Timer data items have a type that determines whether the timer value is seconds and milliseconds or hours, minutes, and seconds. The range of a Seconds timer is 0.00 to 99,999.999. The range of an HMS timer is 00:00:00 to 99:59:59. When a Timer/Counter reaches a “Preset” value, the Timer/Counter sets a “Done” bit.

5.2.1 Duration, Preset, and Retentive Values

Outputs can have a “Duration” measured in seconds (x.xxx) or hours, minutes, and seconds (HH:MM:SS). Outputs that have a duration can be pulsed, flashed, or latched or set (see “Outputs and Flags in Coils” on page 5-9). Outputs without a pre-defined “Duration” are always latched, except in the case of a ladder chart where the output needs to be set to be latched.

Timer/Counters can have a “Preset” that depends on the type (Counter, HH:MM:SS, or Seconds). A preset specifies the ending (“Done”) value for the timer or counter. When reset, the Timer/Counter accumulator goes to zero. When the accumulator reaches the “Preset” value, the Timer/Counter sets the “Done” bit.

To configure a “Duration” or “Preset”:

1. Open the Data Item Editor (see “Using the Data Item Editor” on page 5-3).
2. For digital outputs, enter a value in the “Duration” column; or for Timer/Counters, enter a value in the “Preset” column.

Outputs, Flags, Timer/Counters, and Registers can be retentive. The term retentive indicates that nanoLC writes the value of the data item to flash memory whenever the Runtime project closes or the nanoLC loses power. Retentive data items have initial values equal to their previous value before shut-down.

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To configure a retentive data item:

1. Open the Data Item Editor (see “Using the Data Item Editor” on page 5-3).
2. Select the check box in the “Retentive” column for the appropriate data item rows. Only data items that can be retentive have the “Retentive” column present in the Data Item Editor.

When making a timer retentive, only its accumulator is retentive. The started/stopped and done status aren’t saved. When a project starts or restarts, all timers and counters are initially stopped.

3. Click the check box again to clear the retentive setting (toggles between retentive/non-retentive).

5.2.2 Outputs and Flags in Coils

Outputs and flags can be turned On and Off using the logic within the chart. However, because flow charts and ladder charts evaluate their structure differently, these data item types have some differences. The following defines the “Actions” available in a coil for outputs and flags.

Table 5-1 Output and Flag Actions

	Flow Chart	Ladder Chart
TurnOn	Output/flag is turned ON until a TurnOff command is executed.	Not applicable
TurnOff	Output/flag is turned OFF until a TurnOn command is executed.	Not applicable
On	Not applicable	Output/flag is ON if the rung logic is True. Otherwise, the output/flag is OFF.
Off	Not applicable	Output/flag is OFF if the rung logic is True.Otherwise, the output/flag is ON.
Set	Not applicable	Output/flag is turned ON until a Reset is executed.
Reset	Not applicable	Output/flag is turned OFF.
Pulse (outputs only)	Output is turned ON for the specified duration.	
Flash (outputs only)	Output flashes ON for 50% of the specified duration and OFF for 50% of the specified duration.	

To pulse or flash an output, specify a “Duration” for the output data item in the Data Item Editor (see “Using the Data Item Editor” on page 5-3). Then, use the “Pulse” or “Flash” output “Action” in a Control block or Control coil. When pulsed, the output turns on for the time specified in the “Duration” parameter. After the specified time, the output automatically turns off. When flashed, the output cycles on and off at a 50% duty cycle until it is either turned OFF or ON.

A duration of 0.000 or 00:00:00 results in a one scan duration, which may never be seen because of the time it takes the output to turn ON or OFF. Scan times are in the order of 0.5 - 3 ms, depending on the number of I/O expansion modules and amount of logic.

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5.3 Data Types and Formats

Table 5-2 lists data types supported by nanoNavigator and nanoLC.

Table 5-2 Supported Data Types

Data Type	Prefix	Minimum Value	Maximum Value	Read/ Write	Maximum Data Items	Can Be Retentive?
Analog Input	AI	0	Hardware dependent	Read	8	No
Analog Output	AO	0		Write	8	Yes
Flag	F	0	1	R/W	64	Yes
System Status Flags	F	0	1	Read	8	No
Ethernet Status Flags[1]	F	0	1	R/W	32	No
High-speed Counter	HS	0	99999999	R/W	4	No
Input	I	0	1	Read	32	No
Keypad Key	K	0	1	Read	16	No
Message	MI			R/W	32	No
Output	O	0	1	R/W	32	Yes
Register	R				32	
Integer	R	0	99999999	R/W		Yes
Date	R	01/01/2000	12/31/2250	R/W		Yes
Time of Day	R	00:00:00	23:59:59	R/W		Yes
Day of Week	R	Text day of week		R/W		Yes
HH:MM:SS	R	00:00:00	99 or 99:59 or 99:59:59	R/W		Yes
x.xxx Sec.	R	0.000	99999.999	R/W		Yes
Timer/Counter	TC				32	
Timer	TC	00:00:00 or 0.000	99:59:59 or 99999.999	R/W		Yes
Counter	TC	0	99999999	R/W		Yes

[1] Only visible with an Ethernet module in the configuration.

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5.3.1 Current Date, Day, and Time

Compare blocks and Compare Coils allow access to the real-time clock in the nanoLC to check the current date, day (of week, month, or year), and time. There are specific subtypes for some of these comparisons, and the Compare block and Compare Coil ensures that you select the appropriate subtype. Subtypes that can be used in a Compare to test the current real-time clock are:

Table 5-3 Valid Current Date, Day, Time Comparisons

Compare	Compare to Subtype
Current Date	Date
Current Time	Time of Day
Current Day of Week	Day of Week
Integer	Current Day of Month Current Day of Year

5.4 Using Timers and Counters

nanoLC provides up to 32 Timer/Counter type data items for use in the project. Selecting the format of the Timer/Counter determines whether it operates as a timer or counter.

5.4.1 Timer Items

Timers have a timing range of 0 to 99:59:59 or 99999.999. Each timer is actually a collection of related variables, organized in a *structure* that is accessible in various project tools. Timer variables include the Accumulator (timer value), Preset Value, Timer Done status bit, and Timer Enabled status bit. The Data Item Editor permits specification of a preset value.

Ways in which project components can interact with a timer include:

– A Control block or Coil can start, stop, reset, or restart a timer.
– A Decision block or Contact can use a Boolean expression to check to see if the timer is done or not done; running or not running
– A Compare block or Compare Contact can compare the timer accumulator with another value.
– A Move block or Move Coil can move a value to the timer preset.

Whenever used or enabled for the first time, a timer data item must have the following specified:

– Duration with units of HH:MM:SS (hours and seconds)
– Duration with units of x.xxx seconds (seconds and msec)

In Control blocks and Coils, the following actions on a timer are possible:

– Restart
– Start
– Stop
– Reset

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Start

A Timer Start causes the timer's accumulator to begin timing.

Reset

A Timer Reset sets the timer's accumulator to 0. After a timer expires, it must be reset before starting it again.

Restart

A Timer Restart sets the timer's accumulator to 0 and starts the timer (combines the functions of Reset and Start).

Stop

A Timer Stop causes the accumulator to hold its current value.

5.4.2 Using Counters

Counters are 32-bit values that have a range of 0 to 99,999,999. Counters also have Name, Preset, and Description fields available for access in the Data Item Editor. The main characteristics of Counter data items are:

– Counters can count upward (increment) and downward (decrement).

A Control block or Coil can increment, decrement, or reset a Counter each scan. Counting is not transition-based, as in other types of controllers.

– Specify a Preset for each Counter in the Data Item Editor. The preset is the Counter's ending value.

Ways in which project components can interact with a Counter include:

– A Control block or Coil can increment, decrement, or reset a Counter.
– A Compare block or Compare Contact can compare the Counter's current value with another variable or constant.
– A Move block or Move Coil can replace the current value with a new value or read the current value.

In Control blocks and Coils, the following actions on a Counter are possible:

– Increment
– Decrement
– Reset

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5.5 Using the Move Function

The purpose of the Move block and Move Coil in a chart is to write data from one variable to another. Mathematically, a move data operation is the same as an assignment statement:

MOVE from Data Item A to Data Item B, or

Let B = A

It is important to see the move as an assignment operation or copy because the move is **non-destructive**. That is, moving data from **A** to **B** does not clear A. A still has its original value, but B has a new value equivalent to A.

For readers who are more accustomed to using Load and Out instructions in accumulator-based controllers, just think of the Load-Out combination as the Move block or Move Coil.

5.5.1 The Move Expression

The Move block and Move Coil is a specialized control method in nanoNavigator because it does a specific kind of action. Double-click the block to display the “Move Block” dialog box or double-click the coil to display the “Move Coil” dialog box.

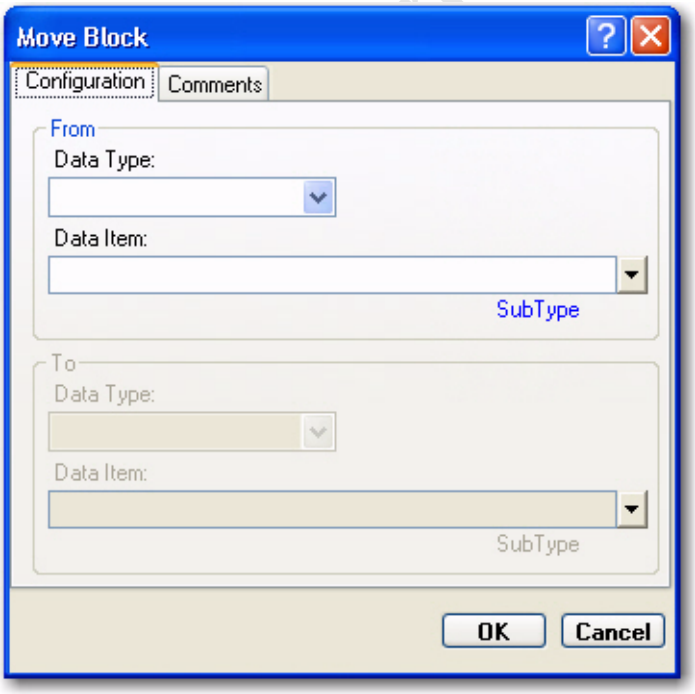

Figure 5-4 “Move Block... Configuration” tab

The dialog box is partitioned into the “From” and “To” groups. Complete the “From” data fields before completing the “To” data fields. nanoNavigator automatically presents only the valid data types in the “To” group based on the data type selected in the “From” group.

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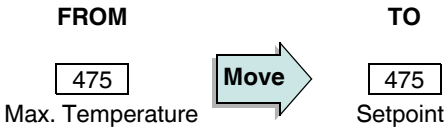
5.5.2 Moving Between Same Data Types

The simplest case is moving data from one data item to another of the same type. The following example uses two data items of the Register/Integer type, making the data item named “Setpoint” equal to “Max. Temperature”.



To perform this type of move, follow these steps:

1. Double-click the Move block to display the “Move Block” dialog box.
2. Select a “Data Type” from the drop-down list in the “From” group.
3. Use the “Data Item” drop-down list to choose an item of the selected type, or type the logical ID (for example, “R-03”), index number (“03”), or data item name.
4. Select a “Data Type” from the drop-down list in the “To” group.
5. Click the “OK” button.

5.5.3 Moving Between Different Data Types

nanoNavigator ensures that the data type of the “To” data item is compatible with the selected “From” data item. For example, moving from a Timer/Counter configured as a Counter to a Register configured as an Integer is possible because counters are, in fact, integers.

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5.5.4 Move Summary

The following table defines all possible Move data combinations.

Table 5-4 Move Summary[1]

		Register							Timer/ Counter						
Data Item Type	**Sub-type**	**Integer**	**Date**	**Time**	**DoW**	**HMS**	**mSec**		**Counts**	**HMS**	**mSec**		**Analog Output**	**HSC**	**Display Format**
Register	Integer	X							X				X	X	xxxxxxxx
	Date		X												dd/mm/yy
	Time			X											hh:mm:ss
	DoW				X										Sun-Sat
	HMS					X				X					hh:mm:ss
	mSec						X				X				xxxx.xxx
Timer/Counter	Counts	X											X		xxxxxxxx
	HMS					X									hh:mm:ss
	mSec						X								xxxx.xxx
Analog In		X													xxxxxxxx
High-speed Counter (HSC)		X													xxxxxxxx
Message Input	Integer	X							X				X	X	xxxxxxxx
	Date		X												dd/mm/yy
	Time			X											hh:mm:ss
	DoW				X										Sun-Sat
	HMS					X				X					hh:mm:ss
	mSec						X				X				xxxx.xxx
Current Date			X												dd/mm/yy
Current Time				X											hh:mm:ss
Current Day of Week (DoW)					X										Sun-Sat
Current Day of Month		X													xx
Current Day of Year		X													xxx
Fixed	Integer	X							X				X	X	xxxxxxxx
	Date		X												dd/mm/yy
	Time			X											hh:mm:ss
	DoW				X										Sun-Sat
	HMS					X				X					hh:mm:ss
	mSec						X				X				xxxx.xxx
	Notes: DoW is Day of the Week														

1 X=valid

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5.6 Handling Analog Values

nanoLC has a powerful set of I/O drivers that understand the difference between discrete (individual) I/O points and I/O data representing numerical values. Some controllers impose tedious programming tasks, such as handling sign bits separately from values, and time de-multiplexing values for 2 to 8 channels from a single data word. nanoLC takes the usual work out of handling analog data.

Scaling Analog Data

Analog values typically have 8 or 12 data bits. Moving analog input values from the I/O system to data items occurs automatically during each scan, but they must be properly configured when selected in the “nanoLC... Configuration” menu.

Analog values begin as unsigned integers. An analog channel may have 8, 10, or 12 data bits. Once converted to an integer, analog data can be handled as any other integer.

nanoLC only supports unsigned integers, so analog values map to positive 12-bit numbers in the default range of 0-4095. Table 5-5 shows the value mapping for the different types of analog devices supported by the nanoLC.

Table 5-5 Analog Value Mapping

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
0	4 mA	0 V	-10 V
2048	12 mA	5 V	0 V
4095	20 mA	10 V	10 V

When configured with scaling values, the nanoLC selects an integer value based on the “Lower Value” and “Upper Value” specified in the analog configuration dialog box (see Figure 5-5) and the input voltage or amperage.

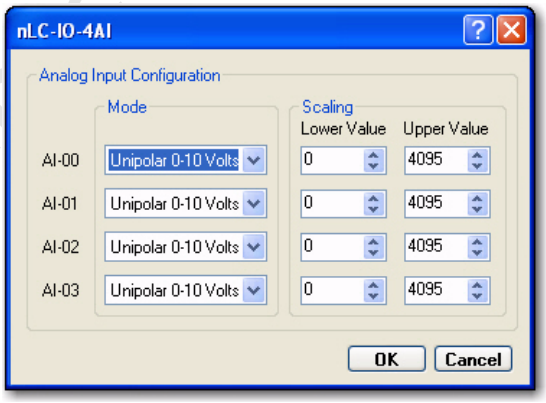

Figure 5-5 The nLC-IO-4AI” configuration dialog box

For example, given an input device on “AI-00” that measures temperature in the range of 70 to 90° on a 0-10 V device, configure the device as follows:

– Set “Mode” to “Unipolar 0-10 Volts”
– Set “Lower Value” to “70”
– Set “Upper Value” to “90”

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In this example, an input of 5 V would appear as a value of 80, while 0 V would be 70, and 10 V would be 90.

For more information on scaling and scaling examples, see Appendix C, “Technical Appendix – Analog Device Scaling”.

5.7 Using Analog Values

To use an analog value in a chart, follow these steps:

1. Add an analog device to the nLC configuration (see “Configuring Analog Inputs” on page 2-11).
2. Provide scaling to the analog input, if desired, by clicking the “Configure” button for the expansion slot that has the analog I/O device.
3. Open the Data Item Editor, and change the label name to a more fitting name for that particular analog input.
4. Use a Move block or coil to move the analog input value to a register.

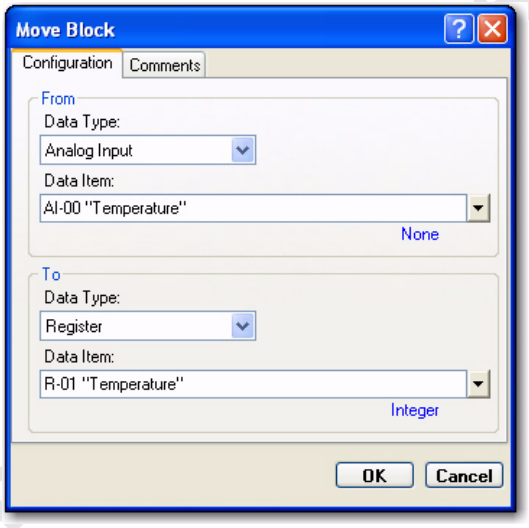

Figure 5-6 “Move Block” dialog box showing analog input to register configuration

Once the analog value is in a register, treat it as any other integer value.

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Section 6

This section provides information about:

– Verifying, downloading, running, stopping projects
– Other nanoLC controls available through nanoNavigator

Running Projects and Controlling the nanoLC 6-3

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6 Running Projects and Controlling the nanoLC

This chapter shows how to prepare a nanoNavigator project to run it, how to transfer a project to or from the nanoLC, and how to start and stop execution on the nanoLC. Note that this discussion involves running a project, not just a flow chart or ladder chart. Whenever updating a chart or closing a project, nanoNavigator ensures that it is error-free (as far as it can tell without actually executing the project). Projects are always ready to download to the connected nanoLC for execution.

6.1 Specifying the PC Connection

Before transferring a project to or from the nanoLC, starting or stopping the project, monitoring it, or performing any other operations on the nanoLC, nanoLC and the PC must be physically connected. Follow these steps:

1. Verify that there is a physical connection between the nanoLC and the PC.

For more information on making a physical connection between the nanoLC and a PC, see the “nanoLC Hardware User Manual.”

The nanoLC Memory Module doesn’t require a physical connection between the nanoLC and the PC, so skip step 1 if defining a connection to a nanoLC Memory Module.

2. Select the “File... Connection Settings” menu to display the “Connection Settings” dialog box (see Figure 6-1). This dialog box permits selection of a COM port for the connection to the nanoLC, and permits specification of a serial port for a nanoLC Memory Module.

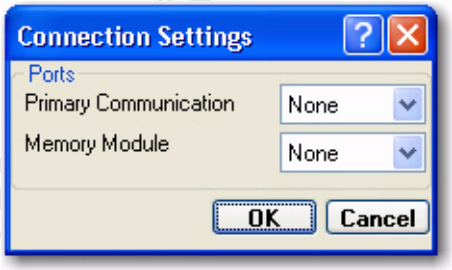

Figure 6-1 “Connection Settings” dialog box

3. Use the “Primary Communication” drop-down list to select from among the available COM ports on the PC. Once selected, upload or download projects from or to the nanoLC (see “Downloading a Project” on page 6-5 and “Uploading a Project from the nanoLC” on page 6-5).

If the nanoLC has a USB Base Unit Option module, a USB cable connects the nanoLC to the PC. The nanoNavigator installation automatically installs a special driver to treat the USB port on the PC as a COM port. The USB port appears as a COM port in this drop-down list.

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4. With a nanoLC Memory Module attached to a USB port on the PC and the special USB driver installed, select the “COM” port to use for communication to the Memory Module. Once installed, upload or download projects from or to the Memory Module (see “Downloading to the Memory Module” on page 6-6 and “Uploading from the Memory Module” on page 6-6).

6.2 Verifying a Project

At any time, it is possible to verify that the project is error-free and consistent with the attached (or configured) nanoLC (see “Configuring nanoNavigator” on page 2-7) by selecting the “nanoLC... Verify Program” menu. This opens the “Project Information... Messages” tab.

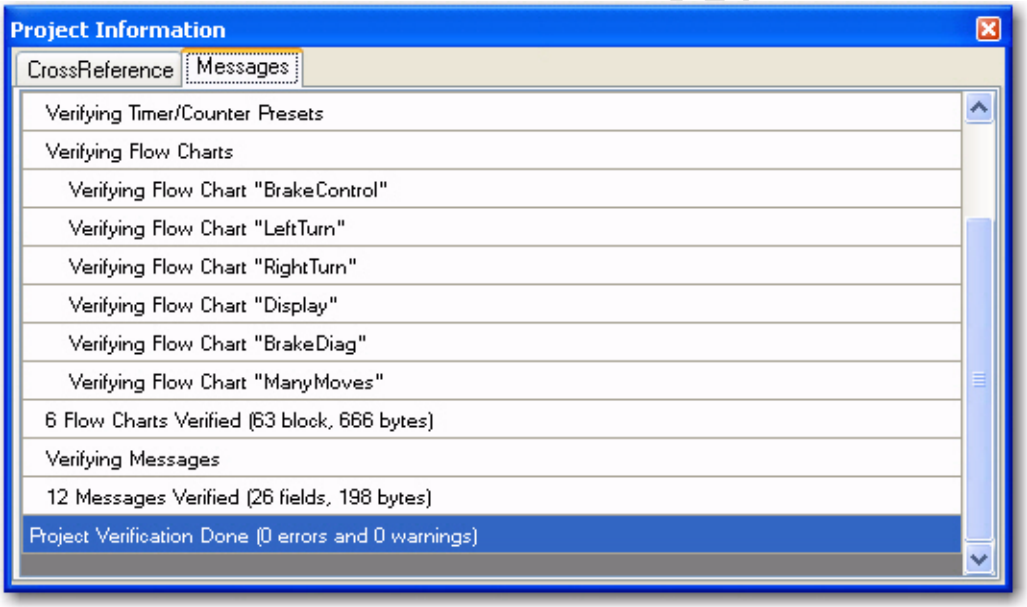

Figure 6-2 The “Project Information... Messages” tab

If the verification process identifies errors, check that the configuration matches the nanoLC intended for project execution. If there are errors identified in a chart, double-click the error message to display the chart containing the error. The error message identifies the chart, specific cell in the chart, type of block, and error cause. With this information, find and correct any problems encountered.

6.3 Connecting to the nanoLC

Before transferring a project to or from the nanoLC, starting or stopping the project, monitoring, or performing any other operations on the nanoLC, connect to it. To perform a software connection from nanoNavigator to the nanoLC, the nanoLC and PC must be physically connected. Follow these steps:

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1. Verify that there is a physical connection between the nanoLC and the PC (see “Connecting to a nanoLC” on page 2-13).

For more information on making a physical connection between the nanoLC and a PC, see the “nanoLC Hardware User Manual.”

2. Perform any operation on the nanoLC, such as “nanoLC... Run”, “nanoLC... Start Monitoring”, “nanoLC... Download”, or “nanoLC... Download & Go”.
   – If a communication port isn’t already selected, nanoNavigator displays the “Select COM Port” dialog box (see Figure 6-3). Use the drop-down list to select the COM port that has the cable connection to the nanoLC.

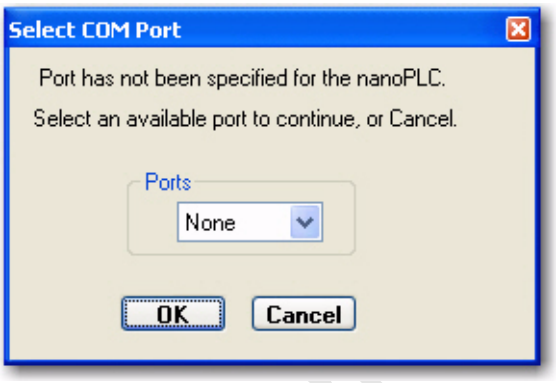

Figure 6-3 “Select COM Port” dialog box

   – If the nanoLC doesn’t have a project loaded, nanoNavigator displays a message.
   – If the nanoLC has a different project loaded, nanoNavigator displays a message and warns that running the nanoLC with a different project loaded in nanoNavigator isn’t possible.

6.4 Downloading a Project

To download a project from nanoNavigator to the nanoLC, select the “nanoLC... Download” menu. This transfers the executable project to the nanoLC. Select the “nanoLC... Download & Go” menu to transfer the executable project to the nanoLC and begin execution. This single menu selection saves, verifies, and then downloads the project to the nanoLC. It then runs the project on the nanoLC.

Although projects can be uploaded to the PC and modified from the uploaded version, the data item names do not get downloaded, so it is important to keep a copy of the original source project on the PC.

6.5 Uploading a Project from the nanoLC

To upload a project to nanoNavigator from the nanoLC, follow these steps:

1. If nanoNavigator currently has a project open, select the “File... Close Project” menu.
2. In the “nanoNavigator Startup” dialog box, select the “Run Connection Wizard” button.
3. In the “nanoLC Connection Wizard” click the “Upload” button.

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- If the original project isn't available, nanoNavigator creates a new project. The data item names in this new project return to their default values.
- If the project exists on the PC, nanoNavigator compares the two versions and displays any differences with a choice to use the logic from the nanoLC or the version on the PC.

6.6 Downloading to the Memory Module

To download a project from nanoNavigator to the nanoLC Memory Module, follow these steps:

1. Attach the nanoLC Memory Module to the PC using the configured USB port (see "Specifying the PC Connection" on page 6-3) and a standard type A to type B USB cable (Order No. 2701247).
2. Select the "nanoLC... Memory Module... Download Project" menu to download the project. This transfers the executable project to the nanoLC Memory Module.

Although projects can be uploaded to the PC and modified from the uploaded version, the data item names do not get downloaded, so it is important to keep a copy of the original source project on the PC.

3. Install the Memory Module in the nanoLC and transfer the project to the nanoLC.

6.7 Uploading from the Memory Module

To upload a project to nanoNavigator from the nanoLC, follow these steps:

1. Attach the nanoLC Memory Module to the PC using the configured USB port (see "Specifying the PC Connection" on page 6-3) and a standard type A to type B USB cable (Order No. 2701247).
2. Select the "nanoLC... Memory Module... Upload Project" menu to upload the project. If there is a project open in nanoNavigator, nanoNavigator closes it (if the project has modifications, nanoNavigator first asks to save the changes).
3. nanoNavigator then uploads the executable project from the Memory Module, and displays the Chart Explorer.
4. Open a chart.
5. Select the "File... Save Project" menu to save the project.

6.8 Clearing the Memory Module

To clear a project from the nanoLC Memory Module, follow these steps:

1. Attach the nanoLC Memory Module to the PC using the configured USB port (see "Specifying the PC Connection" on page 6-3) and a standard type A to type B USB cable (Order No. 2701247).
2. Select the "nanoLC... Memory Module... Clear Project" menu to clear the project from the memory module.

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6.9 Running a Project

Run nanoLC Button

To run a project on the nanoLC from nanoNavigator, follow these steps:

1. If nanoNavigator isn't currently connected to the nanoLC, follow the steps in "Connecting to the nanoLC" on page 6-4.
2. Select the "nanoLC... Run" menu to begin execution or click the "Run" button on the Main toolbar. Running a project always begins execution at the top of each chart. Data Items that are not retentive have their values reset to their initial values.

Stop nanoLC Button

6.10 Stopping a Running Project

The project will continue to run all flow charts and I/O read/writes until halted. To stop the project, connect to the controller (see "Connecting to the nanoLC" on page 6-4), and then select the "nanoLC... Stop" menu or click the "Stop" button on the Main toolbar.

WARNING:

Any machine or process on the I/O network under Runtime control will cease operation. This can lead to dangerous, even life-threatening situations in some applications.

6.11 Set nanoLC Password

To set the password on the nanoLC from nanoNavigator, follow these steps:

1. Select the "nanoLC... Set Password" menu.
2. If nanoLC doesn't have a current password, skip to step 3. If the nanoLC already has a password, the "Current Password" field is available (see Figure 6-4) and requires entry of the current password. Enter the correct current password (a one- to four-digit number).

Figure 6-4 "New Password" dialog box requests the current password

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3. Press the <Tab> key to enable the “New Password” and “Confirmation” fields.
4. Enter a numeric password in the “New Password” field and repeat it in the “Confirmation” field. Valid passwords are from 1 to 9999.

To clear the password, follow steps 1 through 3, above. For the new password, leave both the “New Password” and “Confirmation” fields blank (don’t enter any values or space), and then click the “OK” button.

6.12 Set nanoLC Date/Time

To set the date and time on the nanoLC from nanoNavigator, follow these steps:

1. If nanoNavigator isn’t currently connected to the nanoLC, follow the steps in “Connecting to the nanoLC” on page 6-4.
2. Select the “nanoLC... Set Date/Time” menu. This displays the “Set nanoLC Date & Time” dialog box (see Figure 6-5).

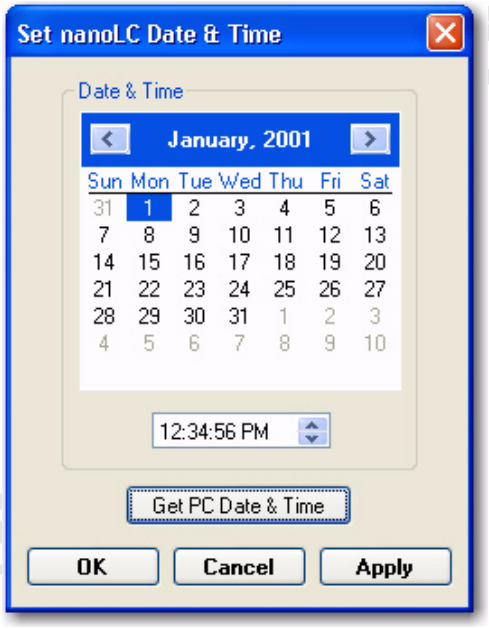
Set nanoLC Date & Time
Date & Time
January, 2001
Sun Mon Tue Wed Thu Fri Sat
31 1 2 3 4 5 6
7 8 9 10 11 12 13
14 15 16 17 18 19 20
21 22 23 24 25 26 27
28 29 30 31 1 2 3
4 5 6 7 8 9 10
12:34:56 PM
Get PC Date & Time
OK
Cancel
Apply

Figure 6-5 “Set nanoLC Date & Time” dialog box

3. To quickly set the date and time to the current date and time of the PC, click the “Get PC Date & Time” button. To set another date and time, use the dialog box calendar and time controls.
   - To change the month and/or year, click the next or previous buttons in the calendar month, year title.
   - To change the hour, minute, or second, select the desired number and either type the number or use the spin button on the right.
   - To change AM/PM, select the letters and either type “A” or “P” or use the spin button on the right.
4. Click the “Apply” button to set the date and time on the nanoLC and leave the dialog box open. Click the “OK” button to set the date and time on the nanoLC and close the dialog box.

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6.13 Lock the nanoLC

When locked, the nanoLC does not permit changes until it is unlocked using the password defined at the time it was locked. To protect the nanoLC from changes using the nanoNavigator, follow these steps:

1. If nanoNavigator isn't currently connected to the nanoLC, follow the steps in "Connecting to the nanoLC" on page 6-4.
2. If necessary, follow the steps in "Set nanoLC Password" on page 6-7.
3. Select the "nanoLC... Lock nanoLC" menu. This displays the "Lock the nanoLC" dialog box (see Figure 6-6).

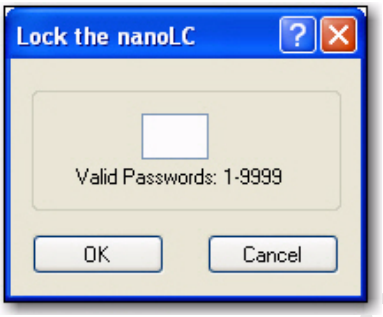

Figure 6-6 The "Lock the nanoLC" dialog box requires the current password

4. Enter the current password, a number from 1-9999, and then click the "OK" button.

6.14 Unlock the nanoLC

To unlock the nanoLC from nanoNavigator, follow these steps:

1. If nanoNavigator isn't currently connected to the nanoLC, follow the steps in "Connecting to the nanoLC" on page 6-4.
2. Select the "nanoLC... Unlock nanoLC" menu. This displays the "Unlock the nanoLC" dialog box (see Figure 6-6).

Figure 6-7 "Unlock the nanoLC" dialog box requires the current password

3. Enter the current password, a number from 1-9999, and then click the "OK" button.

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6.15 Updating nanoLC Firmware

nanoNavigator provides a straightforward capability to update the firmware on the nanoLC.

Only perform this operation when instructed to do so by Phoenix Contact or your local system administrator.

To update the firmware, follow these steps:

1. Start nanoNavigator (see “Starting nanoNavigator” on page 2-4). If already started, close any open project by select the “File... Close Project” menu. You should see the “nanoNavigator Startup” dialog box (see Figure 2-1 on page 2-4).
2. Click the “Run Connection Wizard” button to display the “nanoLC Connection Wizard” (Figure 6-8).

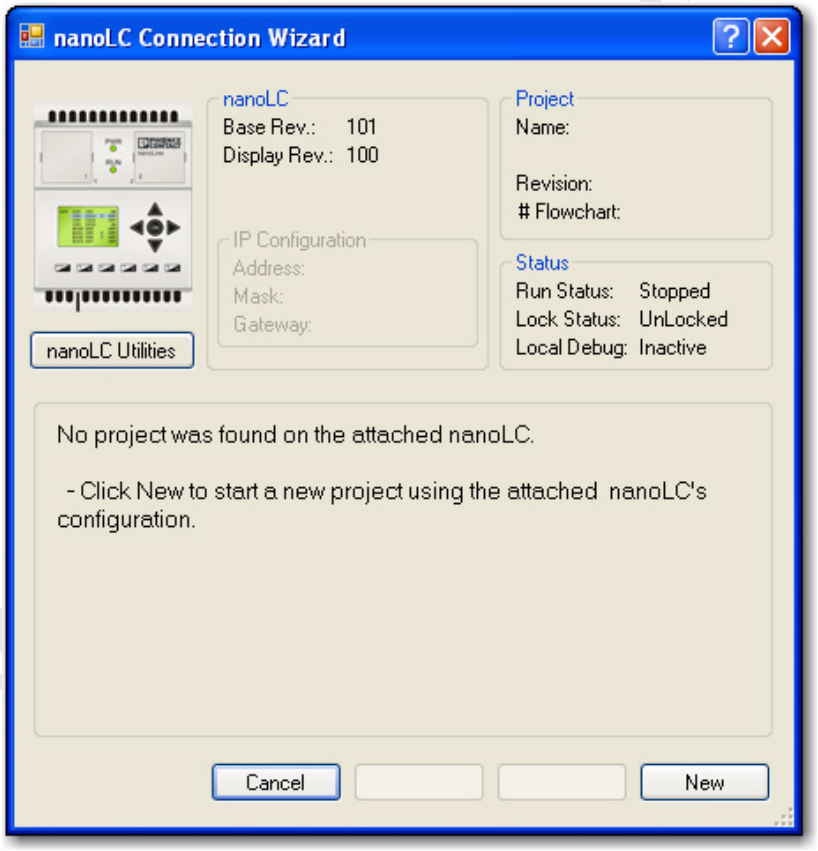

Figure 6-8 The “nanoLC Connection Wizard”

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3. Click the “nanoLC Utilities” button to display the “nanoLC Utilities” dialog box (Figure 6-9).

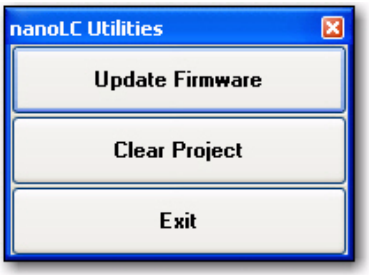

Figure 6-9 The “nanoLC Utilities” dialog box

4. Click the “Update Firmware” button to display the “Update nanoLC Firmware” dialog box (Figure 6-10).

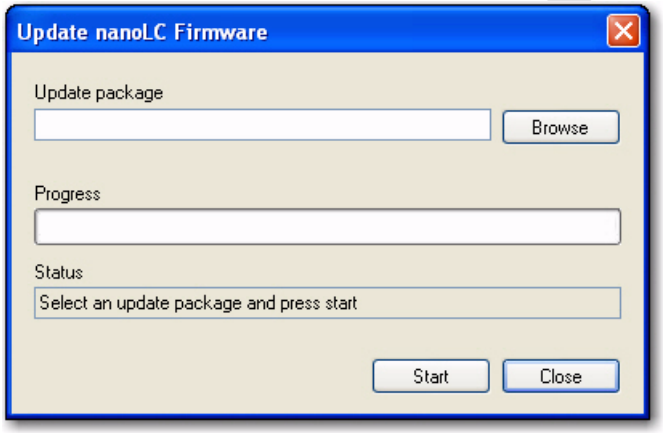

Figure 6-10 The “Update nanoLC Firmware” dialog box

5. Use the “Browse” button to locate the nanoLC update package. Double-click or select the file, and then click the “Open” button.
6. Once the file path appears in the “Update Package” field, click the “Start” button to begin the update process.
7. Follow the on-screen instructions to update the nanoLC firmware and, if present, the display firmware.

You can find additional information for updating the nanoLC firmware by visiting www.download.phoenixcontact.com.

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6.16 Clearing a nanoLC Project

nanoNavigator provides a technique to totally remove a project from the nanoLC. This generally isn't required because loading a new project to the nanoLC automatically removes the old one. However, to manually remove a project, follow these steps:

1. Start nanoNavigator (see "Starting nanoNavigator" on page 2-4). If already started, close any open project by select the "File... Close Project" menu. You should see the "nanoNavigator Startup" dialog box (see Figure 2-1 on page 2-4).
2. Click the "Run Connection Wizard" button to display the "nanoLC Connection Wizard" (Figure 6-11).

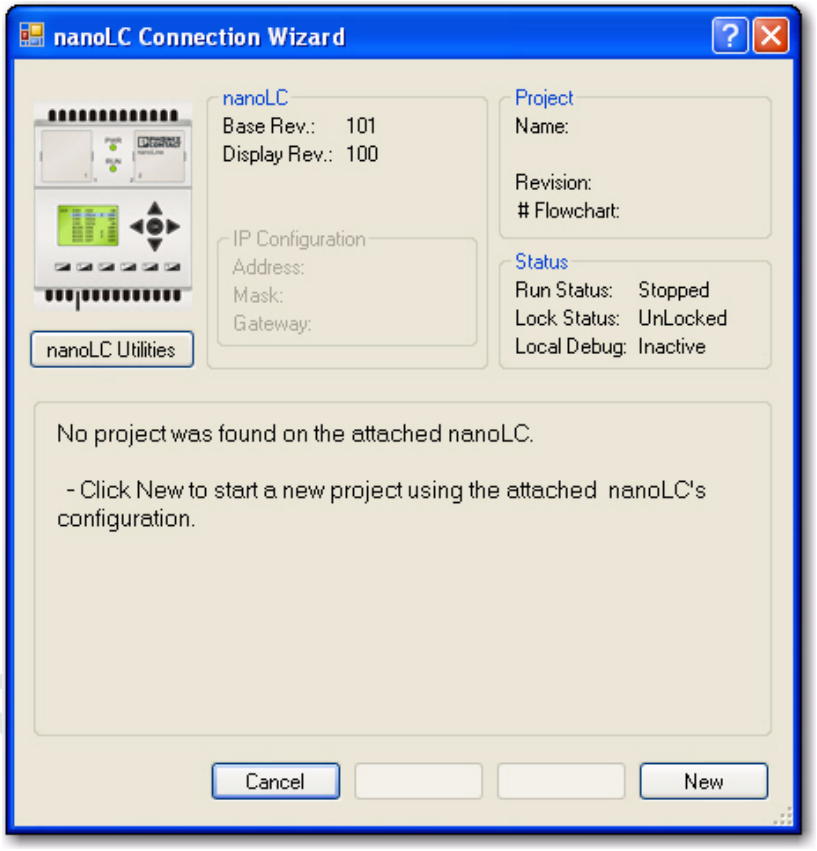

Figure 6-11 The "nanoLC Connection Wizard"

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3. Click the “nanoLC Utilities” button to display the “nanoLC Utilities” dialog box (Figure 6-9).

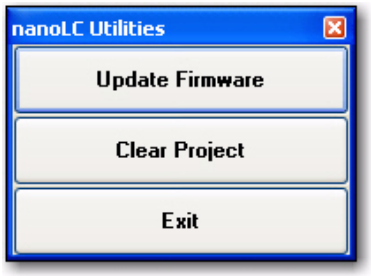

Figure 6-12 The “nanoLC Utilities” dialog box

4. Click the “Clear Project” button.
5. Confirm the operation by clicking the “Yes” button in the warning dialog that appears.

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Section 7

This section provides information about:

– Verifying projects
– Forcing data values
– Using Execution Tracing

Verifying a Project 7-3

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7.1.1 Charts Tab 7-4
7.1.2 Block or Element Tab 7-6
7.1.3 Forces Tab 7-6
7.1.4 System Flags Tab 7-7
7.2 Forcing Data Values 7-7
7.3 Using Execution Tracing in nanoNavigator 7-8

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7 Verifying a Project

nanoNavigator provides verification support (Monitor mode) for nanoLCs. nanoNavigator must be connected to the nanoLC (see section "Connecting to the nanoLC" on page 6-4) before Monitor mode is available. To start Monitor mode, select the “nanoLC... Monitor” menu. In Monitor mode, nanoNavigator displays:

– A “nanoLC Monitor” window that includes four tabs:
  – Flow Chart or Ladder Chart – This tab lists all the data values used or modified in the visible chart. The tab changes to reflect the type of chart.
  – Blocks or Elements – This tab lists all the data values used or modified in a selected block in the chart.
  – Forces – This tab lists all forced data values.
  – System Flags – This tab lists available system flags and their current values.

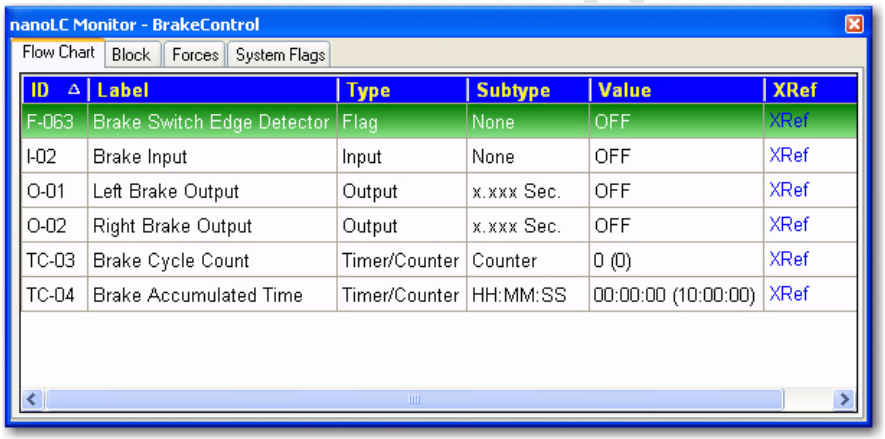

Figure 7-1 Monitor window

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– Display the status of all charts in the project by selecting the “View... Chart Explorer” menu to display the Chart Explorer. This window, in addition to permitting selection of a chart to open, displays the status of each chart (“Enabled” or “Waiting”) and the block or element that is currently executing (see Figure 7-2).

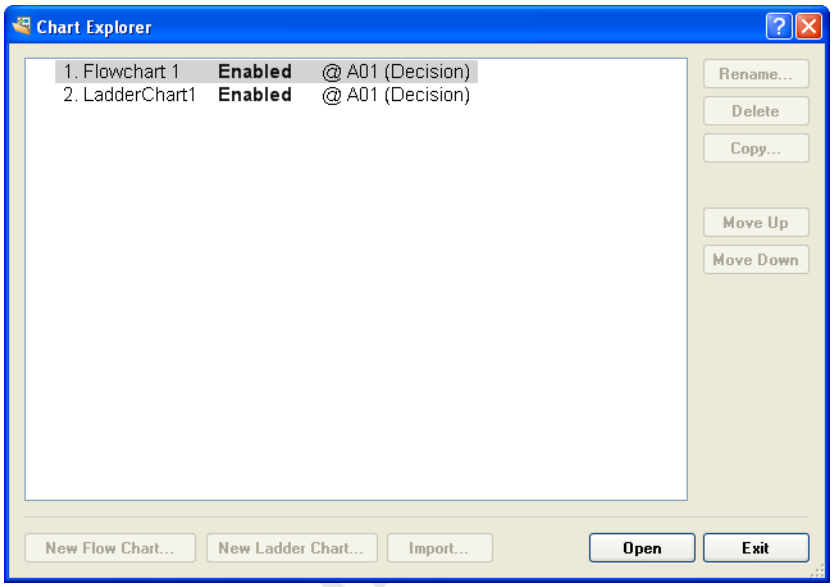

Figure 7-2 Chart Explorer in Monitor mode

– When displaying a chart, it shows the history of execution and the current block or element.

If opening a chart, nanoNavigator displays the running status of that chart. This includes displaying values of data items in selected blocks or elements in a Locals window. It also includes an indication of the executing block or element.

7.1 nanoLC Monitor Window

The “nanoLC Monitor” window opens automatically when selecting the “nanoLC... Start Monitor” menu. This window provides real-time access to data item values. The four tabs display all data items used or modified in the visible chart or a selected block, and all forced data values. The following sections describe these tabs in more detail.

7.1.1 Charts Tab

The “nanoLC Monitor... Charts” tab lists all data values used or modified in the open chart. The name in the tab changes to reflect the type of chart being monitored.

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Use this window to change or force values.

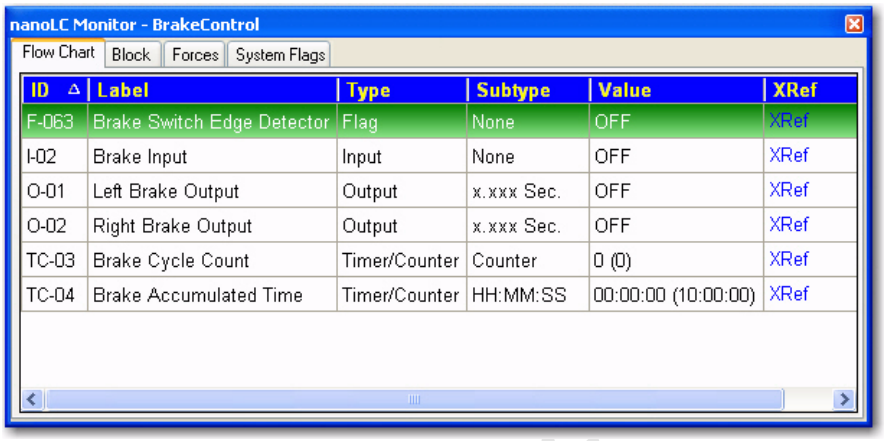

Figure 7-3 The “nanoLC Monitor... Flow Charts” tab lists flow chart data values

To modify or force a data or I/O value, right-click on the row that contains the data item. The pop-up menu has the choices shown in Table 7-1

Table 7-1 Force options available depending on data item type

Type of Data Item	Setting	Description
Input	Force ON	Sets the Input bit ON (see “Forcing Data Values” on page 7-7).
	Force OFF	Sets the Input bit OFF (see “Forcing Data Values” on page 7-7).
	UnForce	Removes Force setting.
Outputs and Flags	Turn ON	Sets the output or flag bit ON. The value can change under program control.
	Turn OFF	Sets the output or flag bit OFF. The value can change under program control.
	Force ON	Sets the output bit or flag ON (see “Forcing Data Values” on page 7-7).
	Force OFF	Sets the output bit or flag OFF (see “Forcing Data Values” on page 7-7).
	UnForce	Removes Force setting.
Registers	Set Value	Displays a pop-up dialog box that permits setting a value for the register.
	Zero Value	Sets the register or timer/counter to zero.
Timer/Counters	Set Accumulator	Displays a pop-up dialog box that permits setting the accumulated count.
	Zero Accumulator	Sets the accumulated count to zero.
	Set Preset	Displays a pop-up dialog box that permits setting the preset done value.
	Zero Preset	Sets the value of the preset done to zero.

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7.1.2 Block or Element Tab

The “nanoLC Monitor... Blocks” tab or “nanoLC... Elements” tab lists all data values used or modified in a selected cell. In addition, use this window to change or force values.

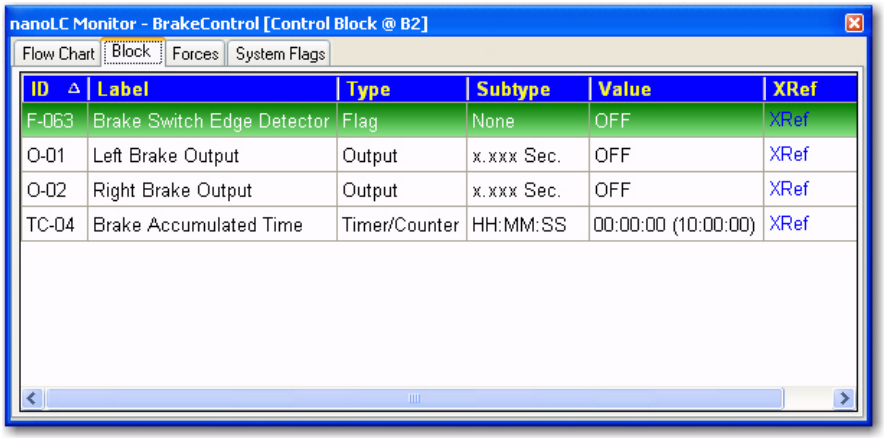

Figure 7-4 The “nanoLC Monitor... Blocks” tab lists a block’s data values

To modify or force a data or I/O value, right-click on the row that contains the data item. The pop-up menu has the same choices listed in “Charts Tab” on page 7-4.

7.1.3 Forces Tab

The “nanoLC Monitor... Forces” tab lists all data values used or modified in the running project. In addition, use this window to change or force values.

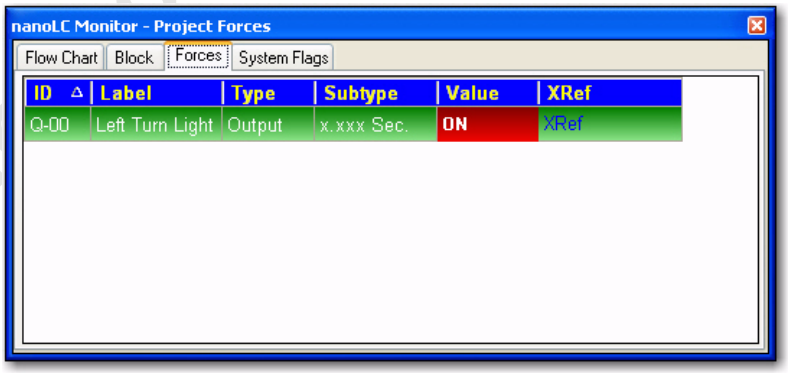

Figure 7-5 The “nanoLC Monitor... Forces” tab lists forced data items

To modify or force a data or I/O value, right-click on the row that contains the data item. The pop-up menu has the same choices listed in “Charts Tab” on page 7-4.

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7.1.4 System Flags Tab

The “nanoLC Monitor... System Flags” tab (see Figure 7-6) lists all system flags available to nanoNavigator and their current value. System flags provide status information that the control program can access. For a list of all available system flags, see “Technical Appendix – System Flags”.

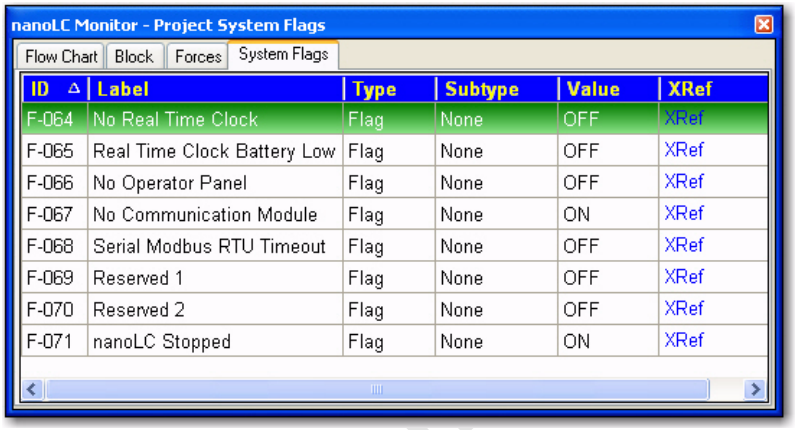
nanoLC Monitor - Project System Flags
Flow Chart
Block
Forces
System Flags
ID
Label
Type
Subtype
Value
XRef
F-064 No Real Time Clock Flag None OFF XRef
F-065 Real Time Clock Battery Low Flag None OFF XRef
F-066 No Operator Panel Flag None OFF XRef
F-067 No Communication Module Flag None ON XRef
F-068 Serial Modbus RTU Timeout Flag None OFF XRef
F-069 Reserved 1 Flag None OFF XRef
F-070 Reserved 2 Flag None OFF XRef
F-071 nanoLC Stopped Flag None ON XRef

Figure 7-6 The “nanoLC Monitor... System Flags” tab lists all system flags

7.2 Forcing Data Values

Use the “nanoLC Monitor... Forces” tab to view all forced items (see Figure 7-5). nanoLC permits forcing input, output, flag data items, and the values of timers/counters. This provides a valuable verification capability. When a data item has a forced value, the value won’t change due to different input states or under program control. However, forcing a data value doesn’t make a permanent programming change, nor does it change a preset value.

Forcing a value doesn’t change a preset or permanently modify the value.

To add forces, follow these steps:

1. Use the “nanoLC Monitor... Charts” tab (see “Charts Tab” on page 7-4) or “nanoLC Monitor... Blocks” tab (see “Block or Element Tab” on page 7-6).
2. Open a chart or select a block that references the data item.
3. Right-click the data item to force.
4. Select “Force On”, “Force Off”, or “Set Value” as desired.

Be sure to remove all forces before running a project in a production environment.

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7.3 Using Execution Tracing in nanoNavigator

Open charts in Monitor mode automatically provide execution tracking. With execution tracking, nanoNavigator color codes blocks or elements to indicate if they were recently executed. The color coding is:

- Green: Always executed on every scan
- Yellow: Sometimes executed
- Red: (Enable block only) The chart is inactive
- Gray: Never executed

These colors are defaults. To select custom colors, see “Debug Tab” on page A-9.

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Section 8

This section provides information about:

- Installing and starting nanoNavigator
- Using flow charting for the first time (Flow Charting Primer)
- Connecting nanoNavigator to the nanoLC
- Creating a flow chart project
- Verifying the project

Flow Chart Tutorial 8-3

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8 Flow Chart Tutorial

8.1 Flow Charting Primer

This flow charting primer is for new users that have no experience with flow chart programming. It provides a brief introduction to flow chart programming concepts specifically as they relate to programming the nanoLC using nanoNavigator.

8.1.1 Introduction and History

Although flow charting predates 1947, it was formally introduced at that time as a way to clearly communicate computer program designs. This 'new method' of using labeled blocks to show the order of a process became so successful that the American National Standards Institute (ANSI) developed standards for flow charts in the early 1970s.

After that, flow charts became a standard for displaying all types of procedures (product launches, quality practices, troubleshooting documentation, etc.), as well as a very reliable means for monitoring and controlling electro-mechanical devices through PC-based programs. This is because people from all walks of life could easily understand a graphical path with instructions of what to do along the way.

Flow charts are step-by-step procedures written using blocks (actions and decisions) and flow lines. Flow lines indicate direction of movement (or path) from block-to-block. Flow charts are simple to write, easy to understand, and programming knowledge isn't required to write a flow chart!

In control programs, flow chart paths return to a desired point in the path – to repeat the process. Generally, it takes multiple flow charts to create a control project, although it is conceivable that simple projects may require only one flow chart.

Control projects are a set of flow charts that control a process. Control projects run on a computer (like the nanoLC or a PC). The computer runs a program that scans through user-designed flow charts in a desired sequence. To do this, projects need to perform the following tasks:

- Control the process by monitoring inputs
- Manipulate outputs as required
- Display status information (normal conditions)
- Display diagnostic information (abnormal conditions)
- Recover from an error

nanoLC solves all flow charts in a project on each scan cycle (for more information on scan cycles and flow chart execution, see "Project Execution" on page 8-19).

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8.1.2 Flow Charts

nanoNavigator uses flow charts to design control programs, and nanoLC executes projects that use flow chart control programs. The symbols in the flow chart depict two classes of items: action blocks and branching blocks.

Action Block

An action block is a box (see Figure 8-1) representing an operation on the data in the system, which may include input or output data. In the flow chart, an action block has one entry point (top) and one exit point (bottom). nanoNavigator has four types of action blocks that are described later (see “Types of Action Blocks” on page 8-5).

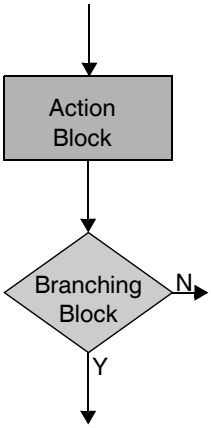

Figure 8-1 Flow chart segment showing an action and branching block

Branching Block

A branching block is a diamond-shaped box (see Figure 8-1) that represents a branch in the control path based on available data. A branching block may compare one variable to another, a variable to a constant, or a true or false condition. Branching blocks have one entry point (top) and two exit points (right side and bottom). nanoNavigator has two types of branching blocks that are described later (see “Types of Branching Blocks” on page 8-5).

Using just action and branching blocks, flow charts can have complete control of I/O systems, or control a machine or process. A project may consist of one or several flow charts.

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Types of Action Blocks

nanoNavigator has three types of action blocks: Control, Message, and Move. Control blocks (see Figure 8-2) initiate an action such as turning on an output or resetting a timer. One Control block can have up to four control expressions. Control expressions set values for flags, turn outputs on and off, and control timers and counters.

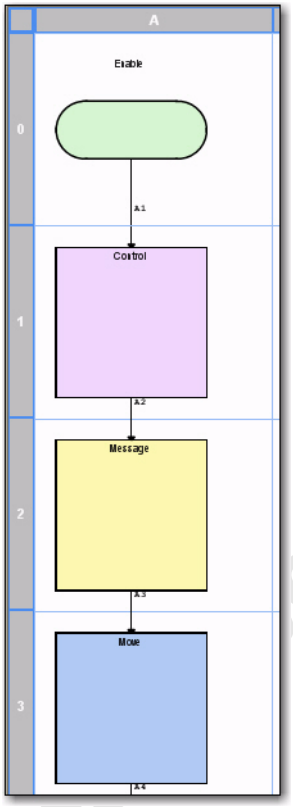

Figure 8-2 Action blocks

Message blocks select a message number (from 0 to 31) to display on the Operator Panel. The Message Editor (see “Using the Message Editor” on page 3-31) specifies messages to display.

Move blocks simply move data from one data item to another. The source data item remains unchanged.

Types of Branching Blocks

Branching blocks (both Decision and Compare blocks) perform a test and determine which of two paths to take after the test. Each branching block has one entry point and two exit points indicating Yes and No paths from the block. By default, the bottom connector is the Yes path, and the right side is the No path.

The standard orientation of a flow chart is top-to-bottom for ease in reading.

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Both Decision and Compare blocks appear as diamonds in the flow chart (see Figure 8-3). Since the Wait block has an implicit branch to itself, it also appears as a diamond.

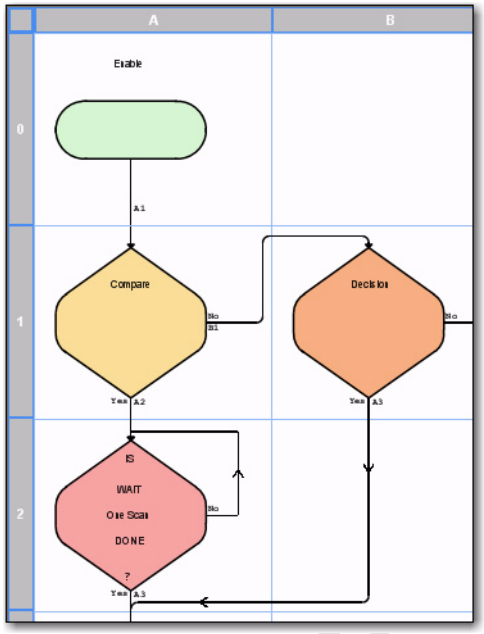

Figure 8-3 Decision, Compare, and Wait blocks appear as diamonds

Decision blocks examine the state of a data item using a Boolean comparison. For example, a Decision block can test inputs or outputs to determine if they are ON or OFF or transitioning from one state to the other. A Decision block can have one or two decision expressions. If there are two expressions, an OR or AND condition links them. For example, a Decision block could have the following expressions:

– Input1 ON AND Input2 OFF

Use Compare blocks to compare two data items. For example, a Compare block can compare an integer register value to a constant or another register. A Compare block can compare values using one of the following comparison operators:

= (Equal To)

> (Greater Than)

< (Less Than)

>= (Greater Than or Equal To)

<= (Less Than or Equal To)

IsEven (doesn't have a second data item to compare to)

The Wait block inserts a wait period in the execution of the flow chart. A Wait block can have a wait period set in seconds or hours, minutes, and seconds as a constant or as a value in a register. If the wait duration is zero, the block defaults to one scan cycle.

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8.1.3 Data Items

Data items provide labels for inputs, outputs, timers, messages, and internal storage. In nanoNavigator, the Data Item Editor labels data items (up to 30 characters). Data items appear in flow chart blocks to control a project. Each label “personalizes” the item (timer, counter, etc.), output (valve, motor, LED, etc.), or monitor (pressure gauge, flow meter, switch, etc.). Personalizing data items helps identify an item’s purpose whenever it’s used in a flow chart block. Therefore, make sure the label (or name) reflects the purpose of the data item. For instance, some input names in a greenhouse project might be: “Greenhouse 3 Temperature”, “GH3 Water Flow Rate”, “GH3 Windows Opened”, “GH3 Windows Closed”; output names might be: “GH3 Valve”, “Open GH3 Windows”, “Close GH3 Windows”, “GH3 Sun Lamps”.

nanoNavigator supports the nine data item types available on the nanoLC. They are:

- **Input** – The number available depends on the configuration of the nanoLC. Inputs are on or off.
- **Analog Input** – An unsigned integer that represents gradually changing voltages/values input to the nanoLC. The number available depends on the configuration of the nanoLC. See “Handling Analog Values” on page 5-16.
- **Output** – The number available depends on the configuration of the nanoLC. Outputs are on or off.
- **Analog Output** – An unsigned integer that represents gradually changing voltages/values output from the nanoLC. The number available depends on the configuration of the nanoLC. See “Handling Analog Values” on page 5-16. Analog inputs provide gradually changing voltages/values.
- **Timer/Counter** – Maximum of 64 total timers and counters.
- **High-Speed Counter** – Maximum of 2. May be enabled or disabled by project.
- **Register** – Maximum of 64. Configurable as Unconfigured, Integer, Date, Time of Day, Duration (HH:MM:SS or msec). Registers can have an initial value and may be retentive (see “Duration, Preset, and Retentive Values” on page 5-8).
- **Flag** – Maximum of 128 binary flags. Flags can have an initial value (set=1) and may be retentive (see “Duration, Preset, and Retentive Values” on page 5-8).
- **Keypad Key** – Maximum of 16 keys available if the optional Operator Panel is present on the nanoLC. The keys include the digits 0-9, four arrow keys, and “OK”. In addition, there is a “Message Input Ready” Keypad Key data item.

8.2 Designing a Control Project

Control projects generally need to accomplish the following four tasks:

- Control a process by monitoring inputs and manipulate outputs in the desired order
- Display status information (normal conditions)
- Display diagnostic information (abnormal conditions)
- Recover from an error

When considering a design, it is important to create modular flow charts that work on small sections of the total project. Using modular design techniques makes it easier to develop, verify, and maintain a project.

The examples on the following pages relate the basics of what needs to be done. They in no way account for the specific events and requirements of each project.

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Because there are common needs in almost every project, certain flow chart structures have become common as well. Each is recognized by its characteristic shape in the same way that building tools (tape measure, hammer, circular saw, etc.) are recognized by their shapes, so it's important to note that flow charts:

– Commonly consist of repeating block patterns. These patterns become easy to recognize what they do by how they're laid out.
– Don't stop at the end, but return to a desired point (determined by the application) in the flow chart to do the work all over again.
– Have label blocks to identify what each block is doing at every step of the process – a very important feature.
– Vary from the examples in this guide depending on what is required, while staying within their intended purpose and behavior.

8.2.1 Auto-mode Flow Chart

Because auto-mode flow charts are written to control process actions automatically, an auto-mode flow chart is the equivalent of a company's project manager with one or two main priorities:

– Initialize the project at the beginning of a flow chart to determine if desired inputs are at the correct state and/or value, set all desired outputs to the correct state and/or value, and then (usually) wait for input from a user and/or machine to begin controlling a process automatically.
– Control the project, which entails reading inputs, controlling actions, for example, starting timers and reading when they're done, updating counters, turning outputs on/off.

Depending on the control process(es), the project could require:

– One flow chart to control the entire project.
– A separate flow chart for each major process to be controlled.

Because auto-mode flow charts control widely different processes, their layout and look vary a great deal, but no matter what it controls, this type of flow chart does three things (see Figure 8-4):

– Turn something on in an action block, like an output to open a greenhouse window, or an output to turn on a sprinkler system, and start a timer to begin timing how long the output should be on.
– Monitor, in a branching block, if the thing turned on is done, for instance, did the opening window hit a switch (an input device used to monitor if something is at a desired position), or is the timer done – signaling that it's time to turn off the sprinkler system?
– Turn off the same output in an action block that was turned on earlier.

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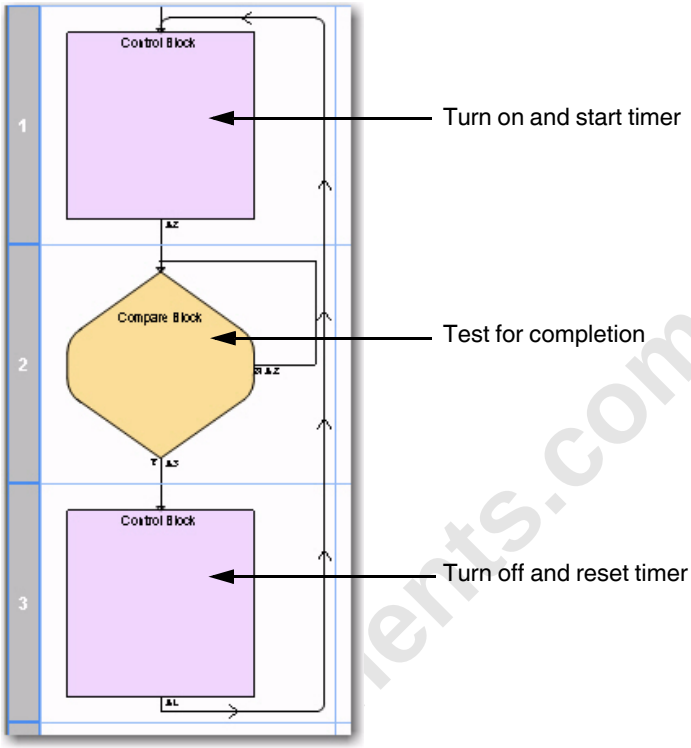

Figure 8-4 An auto-mode flow chart example

Therefore, it's common to use the construct shown in Figure 8-4 along with variations (the blocks don't have to be used next to each other) because, if a flow chart turns something on, it usually needs to turn it off at some point.

As some operations take longer to complete than others, certain auto-mode flow charts will take longer to complete than others.

Example 1: Auto-Mode Flow Chart Controls the Order in Which Processes Occur

In this example, the auto-mode flow chart controls a project the same way every time because flow goes through each process in the same order every time. There are three parts to the flow chart.

- Initialize the project
- Wait for starting event
- Control the process

This example and the next serve as ideas for controlling processes in a project. The project takes everything into account that needs to be controlled in order for the process to operate safely and repeatedly. A project can have more than one auto-mode flow chart if necessary – each controlling a specific process in the project. For example, if a project controls a bowling alley, it could have a flow chart controlling the pin setter, another controlling the ball return, and a third controlling a game display with each flow chart named for the process it controls.

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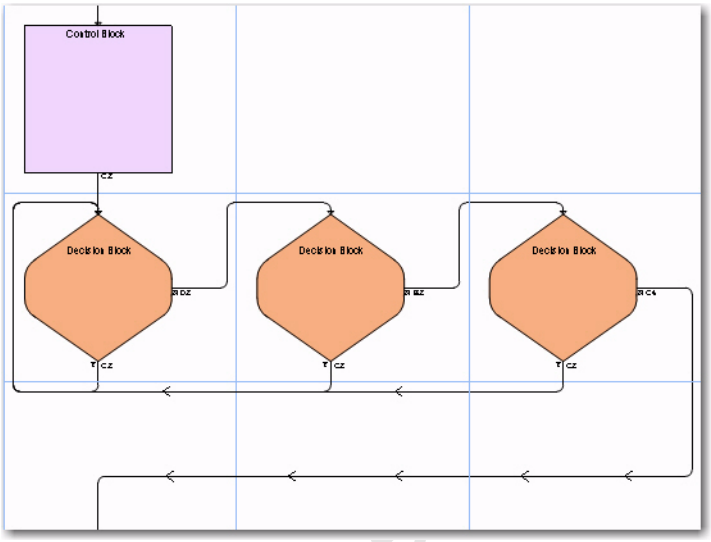
Action blocks at the beginning ensure outputs are turned to desired states (usually OFF), timers and counters reset, etc., so nothing happens until the starting event initiates action (see Figure 8-5). Depending on the needs of the project, use one or more action blocks to perform this initialization.



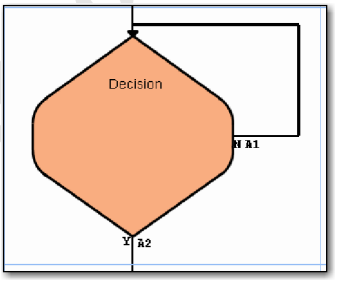
Initialize outputs and timers

Daisy-chain branching blocks to verify all inputs at desired state

Figure 8-5 Initialization of the project could look like this

Branching blocks “daisy-chained” together (see Figure 8-5) ensure that desired inputs are in desired states before the process begins. Depending on the project, use one or more branching blocks for testing conditions, before proceeding to the second part, which waits for a starting event.

In the second part of the project, a decision block waits (see Figure 8-6) for an operator to start the operation by pressing a key or moving a switch to the correct position (on or off).



Wait for start signal

Figure 8-6 Use a branching block to wait for signal to start process

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The third part of the project (see Figure 8-7), controlling the process, turns something on (for instance an output), checks to make sure it's done, and then turns that same output off. After that, flow, in this case, is routed back to the decision block that waits for someone to start the process over again. Depending on the application requirements, flow could be routed elsewhere.

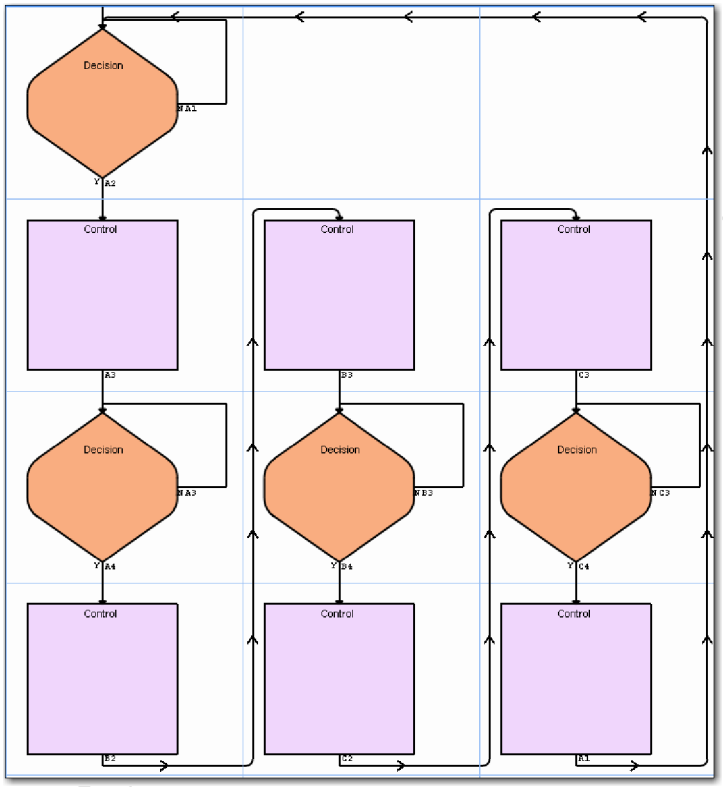

Figure 8-7 Project control consists performing I/O as required

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Example 2: Auto-Mode Flow Charts that Control by Following Process Needs

This example shows two flow charts that control a project by monitoring when something needs to be done and then does it.

The first flow chart (see Figure 8-8) stays in a current action (raising tank temperature, starting the agitation cycle, and adding of catalyst) until that action is done. Therefore, any remaining actions cannot be attempted until the one above it is done. When the last action is taken care of, flow then goes back to the top to see if it's still "Okay to Run" the process. It also checks to see if a user has pressed "Emergency Stop".

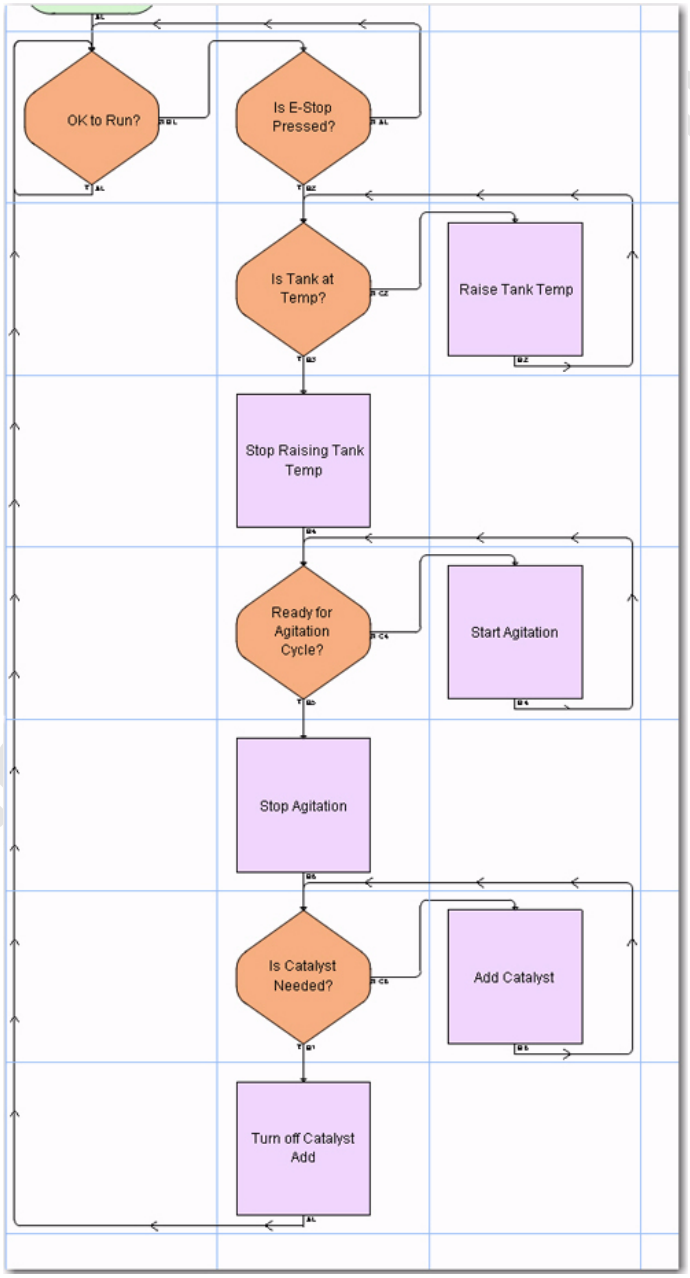

Figure 8-8 Tank control example one

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The second flow chart (see Figure 8-9) shows how to add more initial checks at the beginning with the rest of the flow chart so that each action initiates a function. After examining all process functions, flow returns to the top, verifies that operating conditions are valid, and then repeats.

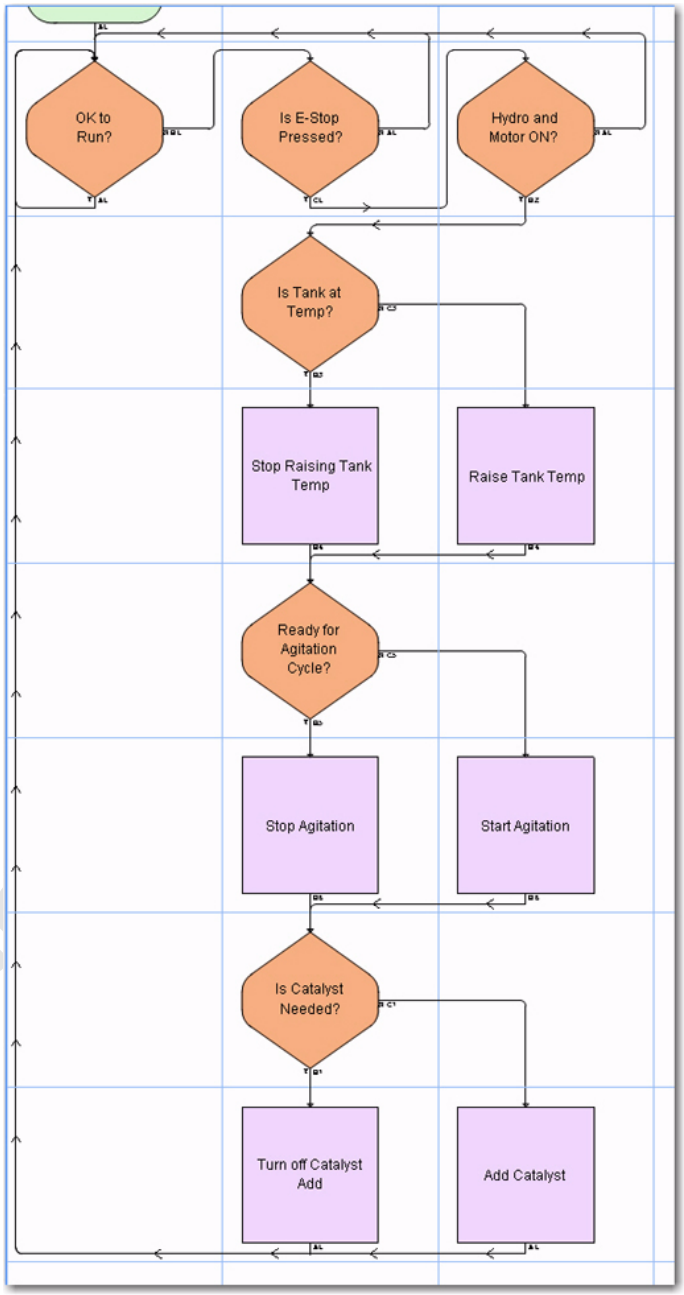

Figure 8-9 Tank control example two

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8.2.2 Status Flow Charts

Status flow charts have a characteristic repeating three-block pattern (see Figure 8-10). This structure is the quickest way to:

– Monitor project events (for example, switches, valves, temperature, pressure, operator actions) in a decision or compare block.
– Immediately display status in associated action blocks.
– Do it all over again.

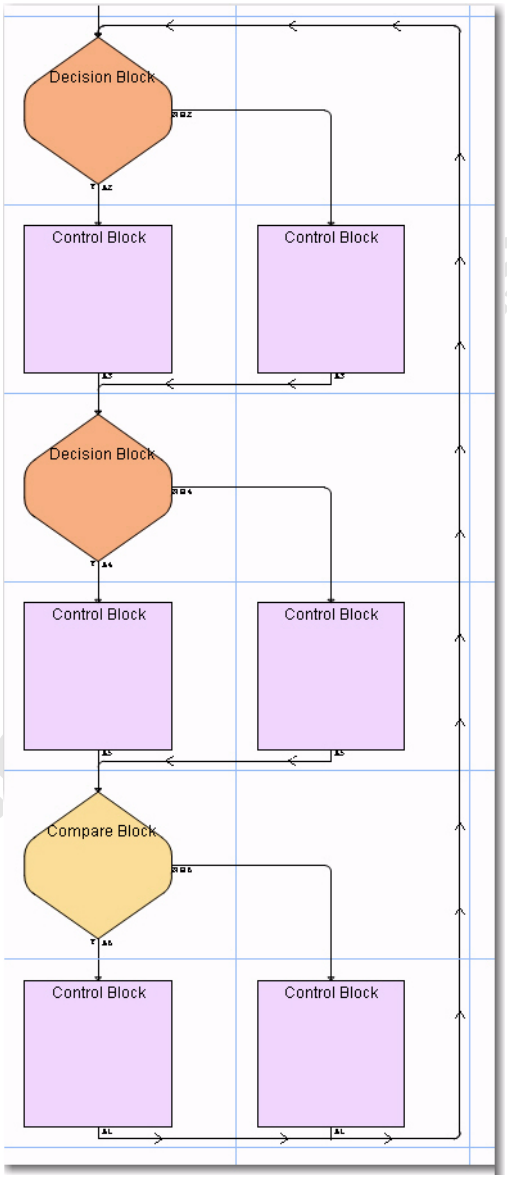

Figure 8-10 Sample status flow chart example

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A key characteristic of this type of flow chart is that no block, between the first and last two blocks, loops a flow line back to itself or to a block above it. Only the last two action blocks loop back to the first block.

When the project is running, this flow chart executes from top-to-bottom every time no matter the path it takes.

Variations on the Status Flow Chart

As long as the flow chart doesn't loop back to any of the inner blocks, there are many conceivable variations on the basic status flow chart. Figure 8-11 and Figure 8-12 show two possibilities.

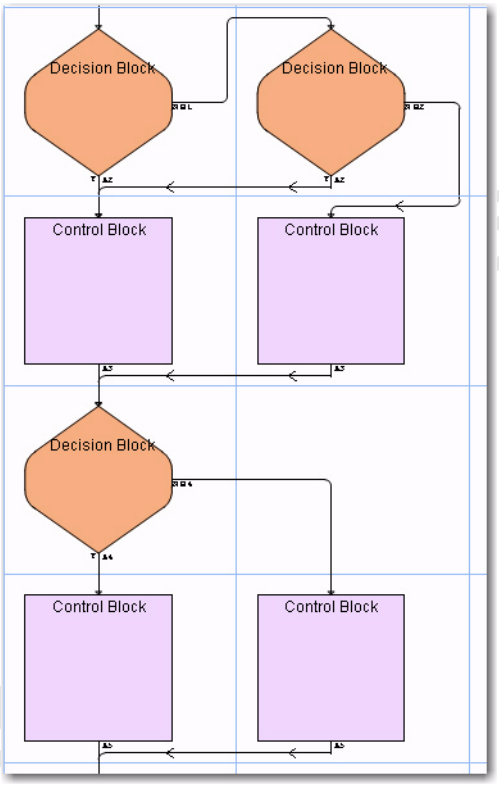

Figure 8-11 Sample status flow chart variation 1

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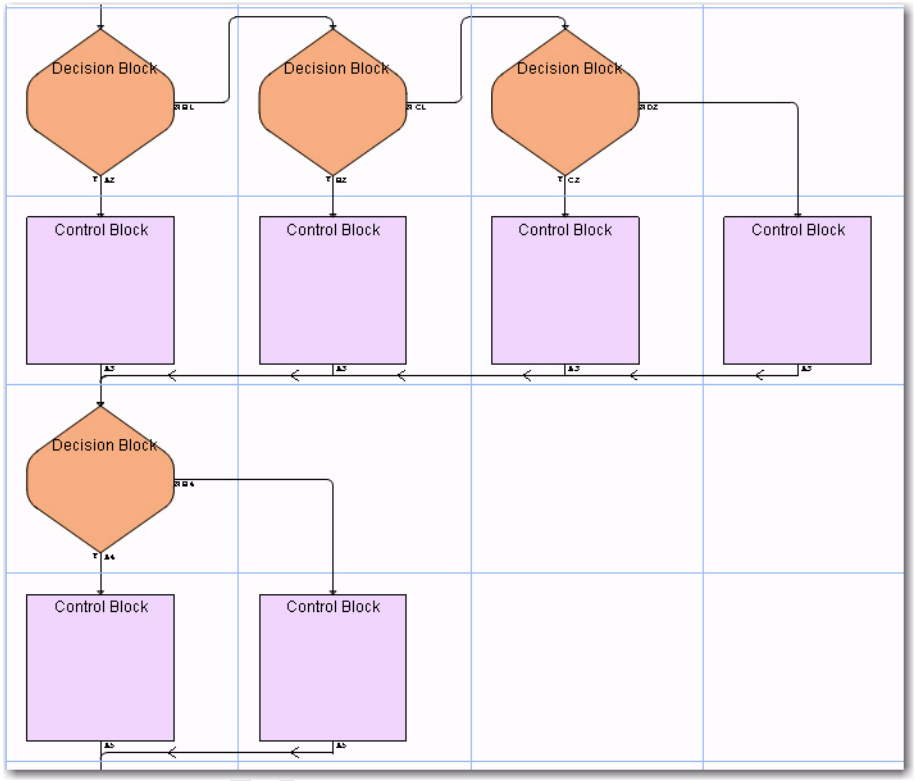

Figure 8-12 Sample status flow chart variation 2

8.2.3 Diagnostic Flow Chart

A diagnostic flow chart looks for any project-stopping errors (for example, an Emergency Stop) and current process actions, which usually originate in the auto-mode flow chart(s). When an action is in progress, the diagnostic flow chart looks for faults. These faults can be improbable, probable, and those that indicate an error when an event doesn't occur after a certain period of time. If a fault occurs, the diagnostic flow chart displays a message, or turns necessary outputs ON or OFF (for example, turn on an LED to indicate a specific error, turn off a motor to stop a given action), which can vary per error, application requirements, and safety regulations.

Flow then goes back to the next decision block to check if the next error occurred for that same action. Once the flow chart has checked all possible error conditions for a given action, the flow chart checks to see if the next action is occurring.

Whether or not an error occurred, the flow chart checks to see if an operator cleared a fault that may have occurred. If so, the flow chart clears the existing error message and turns off any error indicators.

Figure 8-13 illustrates a diagnostic flow chart for a greenhouse application. Although it does not show all possible error conditions, it provides an excellent example of the concepts discussed above.

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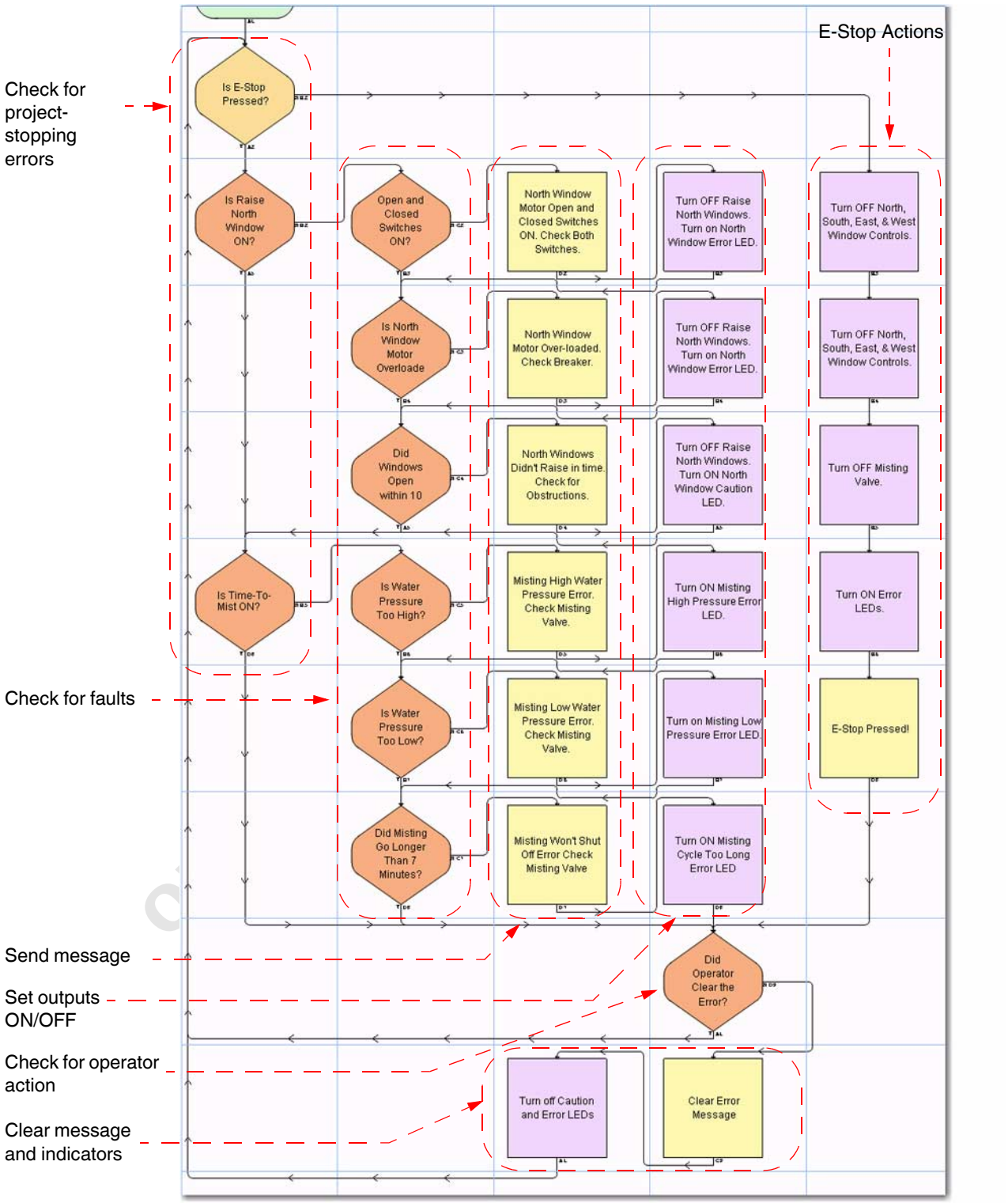
Check for project-stopping errors
Check for faults
Send message
Set outputs ON/OFF
Check for operator action
Clear message and indicators
E-Stop Actions
Is E-Stop Pressed?
Is Raise North Window ON?
Is Time-To-Mist ON?
Open and Closed Switches ON?
Is North Window Motor Overloade
Did Windows Open within 10
Is Water Pressure Too High?
Is Water Pressure Too Low?
Did Misting Go Longer Than 7 Minutes?
North Window Motor Open and Closed Switches ON. Check Both Switches.
North Window Motor Over-loaded. Check Breaker.
North Windows Didn't Raise in time. Check for Obstructions.
Misting High Water Pressure Error. Check Misting Valve.
Misting Low Water Pressure Error. Check Misting Valve.
Misting Won't Shut Off Error Check Misting Valve
Turn OFF Raise North Windows. Turn on North Window Error LED.
Turn OFF Raise North Windows. Turn on North Window Error LED.
Turn OFF Raise North Windows. Turn ON North Window Caution LED.
Turn ON Misting High Pressure Error LED.
Turn on Misting Low Pressure Error LED.
Turn ON Misting Cycle Too Long Error LED
Turn OFF North, South, East, & West Window Controls.
Turn OFF North, South, East, & West Window Controls.
Turn OFF Misting Valve.
Turn ON Error LEDs.
E-Stop Pressed!
Did Operator Clear the Error?
Turn off Caution and Error LEDs
Clear Error Message

Figure 8-13 Sample diagnostic flow chart

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The diagnostic flow chart shown in Figure 8-13 illustrates general layout and ideas generally needed in diagnosing faults. It doesn't account for the specific needs of all projects. Depending on project needs, including applicable safety regulations and considerations, it's possible to write diagnostic flow charts to look for one or more errors for a given action (the example shows checking for three possible errors for any given action). Therefore, the size and layout of a specific project diagnostic flow chart will vary from this one. However, the functionality should be very close.

8.2.4 Recovery Flow Chart

The job of a recovery flow chart is to put all outputs (such as a window controls and valves) back to a safe position and/or state after a fault occurs.

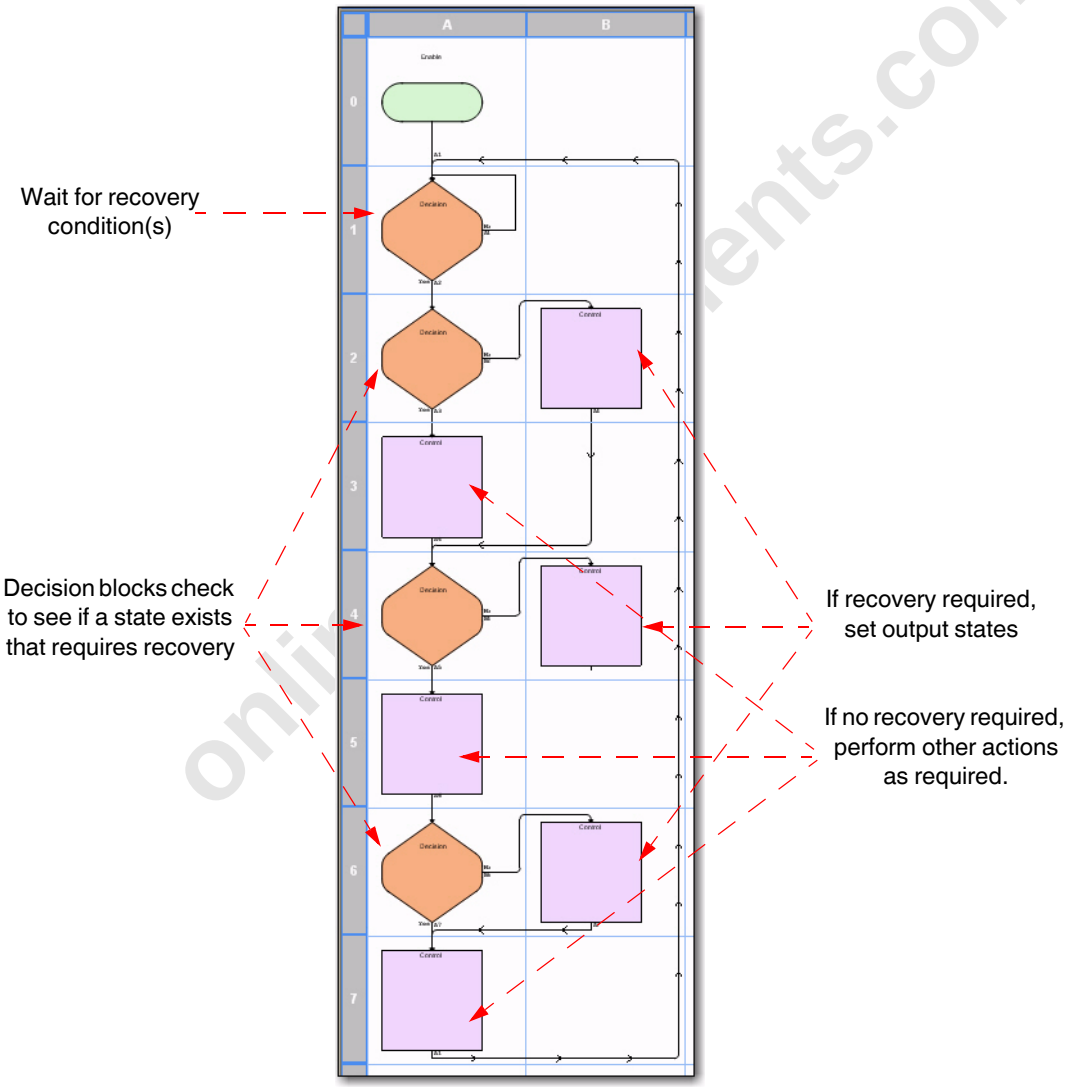
Wait for recovery condition(s)
Decision blocks check to see if a state exists that requires recovery
If recovery required, set output states
If no recovery required, perform other actions as required.

Figure 8-14 Sample recovery flow chart

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Important characteristics of its structure are:

– Each recovery task checked and acted on independently.
– With the exception of the top decision block looping on itself (very important for this flow chart), the rest of the recovery flow chart is similar to a status flow chart (Figure 8-12 on page 8-16).

With greater familiarity creating flow charts using nanoNavigator, consider removing the top decision block and placing the recovery condition testing in the Enable block (see “Enable Block” on page 3-13).

8.3 Project Execution

When the nanoLC is in run mode, it repeatedly scans through the project and executes flow chart(s). Project execution occurs in the following sequence:

– Check the state (digital) and value (analog) of all inputs.
– Solve all enabled flow charts in numeric order, skipping any flow charts that are disabled (see “Solving Flow Charts”).
– Send updated digital outputs.

Each scan cycle includes completion of these three steps, and the nanoLC continuously repeats scan cycles until explicitly stopped or turned off.

8.3.1 Solving Flow Charts

On the first scan after selecting “run” on the nanoLC or the “nanoLC... Run” menu in nanoNavigator, the nanoLC executes each enabled flow chart in the order in which it appears in the Chart Explorer (see “Flow Chart Execution Order”). In each enabled flow chart, execution begins with the block connected to the Enable block (see “Enable Block” on page 3-13). The scan continues in that flow chart until a flow line routes back to a block that has already been scanned. It marks that block and leaves the flow chart to scan the next enabled flow chart in the same manner until all enabled flow charts have executed. It then sends all updated outputs (ON or OFF) to output devices. On the next and following scans, the nanoLC reads inputs, executes enabled flow charts starting where it left off (at the “marked block”) continuing until flow routes back to a block that’s already been examined in this particular scan, and then sends updated outputs. This continues until the nanoLC is turned off.

8.3.2 Flow Chart Execution Order

As discussed above, nanoLC executes all flow charts in every scan cycle. Use the Chart Explorer to specify the order of chart execution (see “Changing Execution Order” on page 3-8).

The Chart Explorer displays both flow charts and ladder charts. Execution order is based on the order specified in the Chart Explorer regardless of the type of chart.

Because it’s possible to have more than one flow chart controlling the same output (for example, one or more auto-mode flow charts, a diagnostic flow chart, and a recovery flow chart), consider placing the diagnostic flow chart last in the list or next-to-last before the recovery flow chart.

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The nanoLC scans flow charts in numeric order as they appear in the Chart Explorer (shown Figure 8-15) starting with the flow chart at #1 (“Status” in the example), then #2, and so on. Therefore, if more than one flow chart is controlling a given output, the enabled flow chart with the highest number on the list has the highest precedence for that output in each scan. In other words, if flow chart #2 turns an output on and flow chart #3 turns it off, the output would be off once the outputs are sent to the bus.

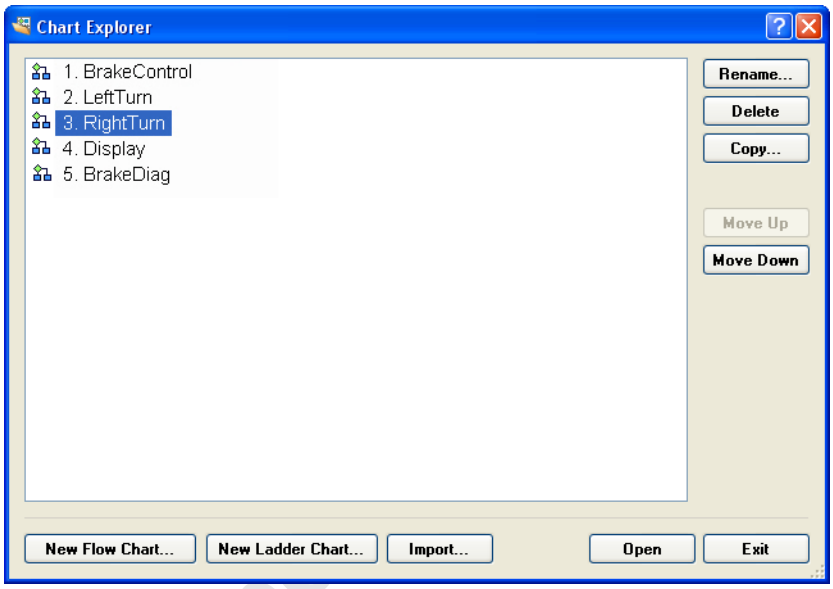

Figure 8-15 Flow Chart Explorer

If there is only one flow chart in the project, the last block to control the output in the current scan has precedence.

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8.4 Creating a Project

This sample project is a control program for vehicle lights including turn indicators and brake lights. With flow chart programming, it is easy to create a project using nanoNavigator. To begin, notice that the flow chart workspace looks like a spreadsheet with row numbers and column letters (see Figure 8-16). Identify specific cells of the workspace as with a spreadsheet, so cell A0 is the first cell in the upper-left corner, and cell B0 is the cell in the second column, first row.

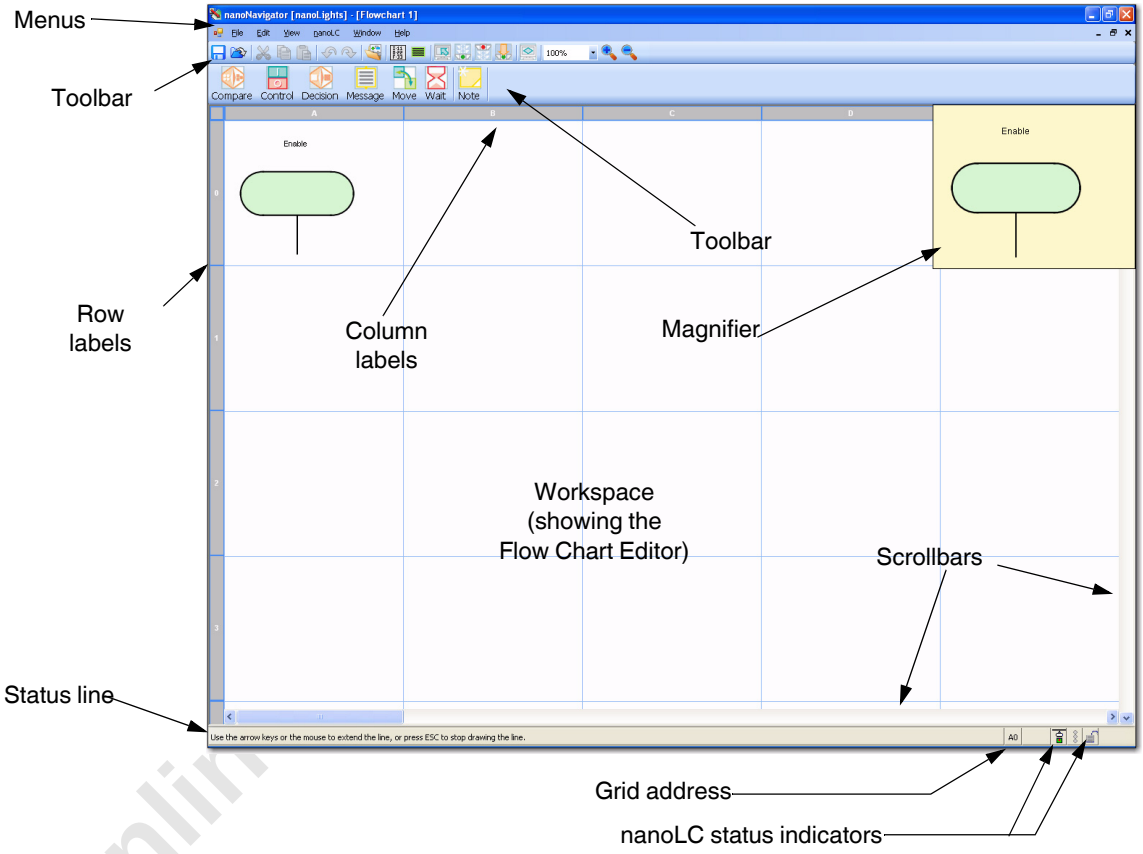

Figure 8-16 Initial flow chart window

A new flow chart always has an Enable block in cell A0. For more information about the Enable block, see “Enable Block” on page 3-13. The Block toolbar provides easy placement of different flow chart blocks in the workspace. It is above the flow chart workspace. The basic technique is to click a Block toolbar button, and then click a cell location in the workspace to drop the block in position. Flow charts can only have one block per cell.

For further information on the elements on the nanoNavigator window and Flow Chart Editor, see “Exploring Flow Charts” on page 3-3.

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8.4.1 Creating the Brake Control Program

To begin creating the vehicle brake light control program, follow these steps:

1. Click the “Decision” button in the Block toolbar.
2. Click cell A1 to drop the Decision block (for more information on Decision blocks, see “Branching Blocks” on page 3-14 and “Decision Block” on page 4-35).

nanoNavigator also supports drag-and-drop of a block from the toolbar to a cell in the flow chart.

3. Click the “Control” button in the Block toolbar.
4. Click cell A2, and then repeat to place a Control block in cell B2 (for more information on Control blocks, see “Action Blocks” on page 3-22 and “Control Block” on page 4-33).

Now, enter control information in each block. To do that, follow these steps:

1. Double-click the Decision block to display the “Decision Block... Configuration” tab (see Figure 8-17). Use this dialog box to specify a True/False condition to test.

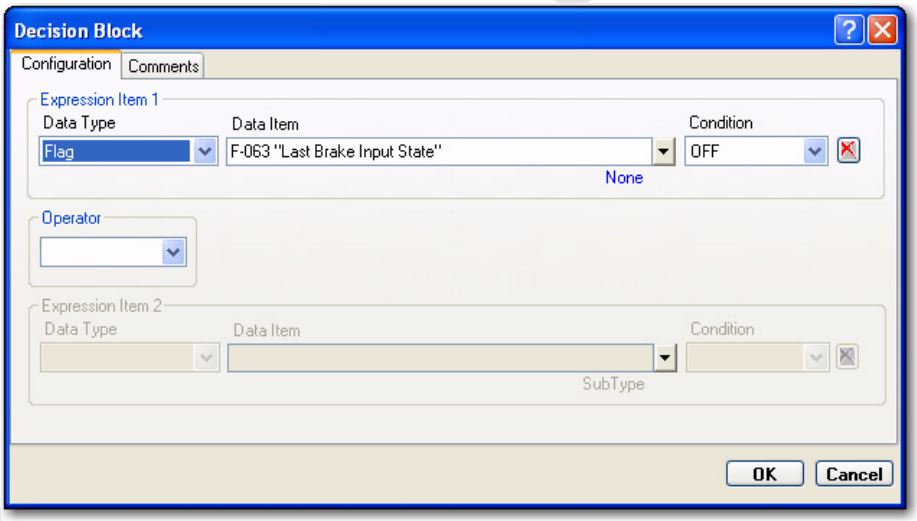

Figure 8-17 The “Decision Block... Configuration” tab

2. Use the “Data Type” drop-down list to select “Input”.
3. Use the “Data Item” drop-down list to select “I-02”.
4. Use the “Condition” drop-down list to select “ON”.
5. Click the “OK” button. Notice that the Decision block now displays “IS Input 02 ON”.

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Using Meaningful Data Item Names

nanoNavigator provides for the creation of meaningful names for inputs, outputs, and all other data item types. To create meaningful names of up to 30 characters, use the Data Item Editor. Follow these steps to create a meaningful name for Input 02:

1. Select the “View... Data Items” menu to display the Data Item Editor.

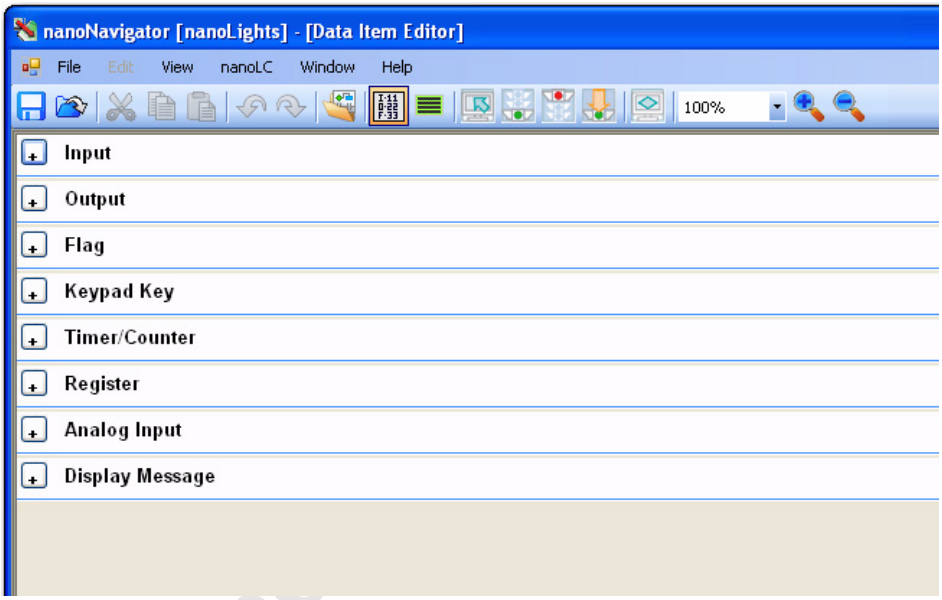

Figure 8-18 The Data Item Editor initially displays all available data types

2. Click the plus (+) sign in front of “Input” to display available inputs. The number of inputs that appear depends on the configuration of the nanoLC.
3. In the “Label” column, select “Input 02”.
4. With “Input 02” selected, type “Brake Input”. This is the new, friendly name for “Input 02”. Notice that this input has “I-02” in the “DI” column. This is the data item name used on the nanoLC. In nanoNavigator, use either the “DI” or the friendly name in the “Label” column. In most cases, nanoNavigator displays both names.

Friendly data item names aren’t stored or displayed on the nanoLC. On the nanoLC, reference data items by the “DI” name.

5. Continue naming data items needed, or wait and name them as programming continues. For this tutorial, create the data items listed in Table 8-1.

For more information on Retentive data items, see “Duration, Preset, and Retentive Values” on page 5-8. For more information on timers, see “Using Timers and Counters” on page 5-11.

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Table 8-1 Data Items for Brake Control Example

Data Type	DI	Label	Retentive	Type	Duration
Input	I-00	Left Turn Input			
Input	I-01	Right Turn Input			
Input	I-02	Brake Input			
Input	I-03	Hazard Input			
Output	O-00	Left Turn Output			
Output	O-01	Left Brake Output			
Output	O-02	Right Brake Output			
Output	O-03	Right Turn Output			
Timer/Counter	TC-00	Left Turn Timer	Y	Seconds	.800
Timer/Counter	TC-01	Right Turn Timer	Y	Seconds	.800
Timer/Counter	TC-02	Hazard Timer	Y	Seconds	.500

Add Control Block Expressions to Brake Control

Now, return to the flow chart view to continue programming the Brake Control flow chart. In this section, add expressions to the two Control blocks. Follow these steps:

1. Select the “Window... Flow chart 1” menu.
2. Double-click the Control block in cell A2 to display the “Control Block” dialog box.
3. In “Expression Item 1”, select the following from the drop-down lists:
   - Data Type = Output
   - Data Item = Left Brake Output
   - Action = TurnOn
4. In “Expression Item 2”, select the following from the drop-down lists:
   - Data Type = Output
   - Data Item = Right Brake Output
   - Action = TurnOn
5. Click the “OK” button.
6. Now, double-click the Control block in cell B2 to display its “Control Block” dialog box.
7. In “Expression Item 1”, select the following from the drop-down lists:
   - Data Type = Output
   - Data Item = Left Brake Output
   - Action = TurnOff
8. In “Expression Item 2”, select the following from the drop-down lists:
   - Data Type = Output
   - Data Item = Right Brake Output
   - Action = TurnOff
9. Click the “OK” button.

Now that all the blocks in the flow chart are defined, it’s time to connect them to show the direction of flow.

Connect flow chart blocks at any time – before or after entering expressions in one or more blocks.

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Connect Flow Chart Blocks

In this section, connect the blocks to show how control flows from one block to another. Follow these steps:

1. Hover the mouse pointer over the line extending out of the bottom of the Enable block. The region around the exit point of the block highlights in a semi-circle with its center at the exit line.
2. Click anywhere in the highlighted region.
3. Move the mouse pointer down to the top of the Decision block. A line extends out of the exit point and grows as the mouse moves.
4. When the top of the Decision block highlights, click anywhere in the highlighted region to define the end point of the connection.
5. From the bottom of the Decision block, click the exit region, and then click the entry region of the Control block at A2.
6. From the bottom of the Control block at A2, click the exit region, move the mouse pointer to the entry region of the Decision block at A1, and then click. nanoNavigator automatically chooses the best route for the line.
7. From the right side of the Decision block, click the exit region, and then click the entry region of the Control block at B2.
8. From the bottom of the Control block at B2, click the exit region. Move the mouse pointer to the entry region of the Decision block at A1, and then click. nanoNavigator automatically chooses the best route for the line.

The completed flow chart should look like Figure 8-19.

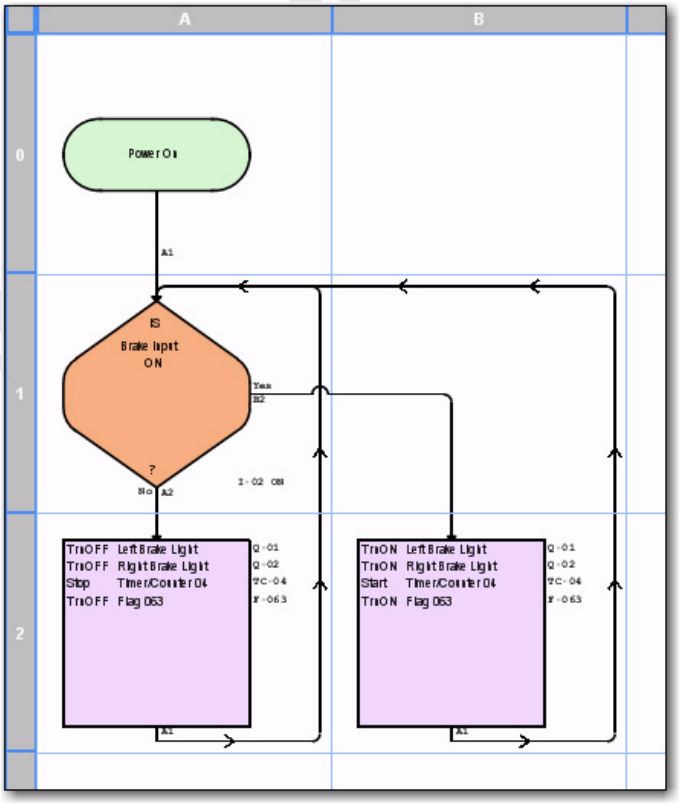

Figure 8-19 Brake control flow chart

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Saving the Program

Now, save the flow chart program. Follow these steps:

1. Select the “File... Save Flow Chart” menu.
2. In the “Flow Chart Name” dialog box, enter “BrakeControl”.
3. Click the “OK” button.

8.4.2 Creating Left Turn Flow Chart

Create the left turn flow chart using the same techniques described in creating the brake control flow chart. Follow these steps:

1. Select the “File... New Flow Chart” menu.
2. Use Table 8-2 to create the flow chart blocks and enter expressions in each block.

Table 8-2 Left Turn Flow Chart Blocks

Block Type	Cell	Expression 1	Expression 2
Decision	A1	Input; “Left Turn Input”; ON	
Control	B1	Timer/Counter; “Left Turn Timer”; Stop	
Control	A2	Output; “Left Turn Output”; TurnOn	Timer/Counter; “Left Turn Timer”; Restart
Decision	A3	Timer/Counter; “Left Turn Timer”; Done	
Decision	B3	Input; “Left Turn Input”; ON	
Control	A4	Output; “Left Turn Output”; TurnOff	Timer/Counter; “Left Turn Timer”; Restart
Decision	A5	Timer/Counter; “Left Turn Timer”; Done	
Decision	B6	Input; “Left Turn Input”; ON	
Control	C6	Output, “Left Turn Output”; TurnOff	

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3. Connect the flow chart blocks as indicated in Table 8-3.

Table 8-3 Flow Line Connections

Cell	From Bottom	From Right	To
A0	X		A1
A1	X		A2
A1		X	B1
B1	X		A1
A2	X		A3
A3	X		A4
A3		X	B3
B3		X	A3
B3	X		C6
A4	X		A5
A5	X		A1
A5		X	B6
B6	X		C6
B6		X	A5
C6	X		A1

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The completed flow chart should look like Figure 8-20 and Figure 8-21. If the flow lines don't look like this, see "Manually Creating Flow Lines" below. Be sure to save the flow chart and give it a descriptive name, like "LeftTurn".

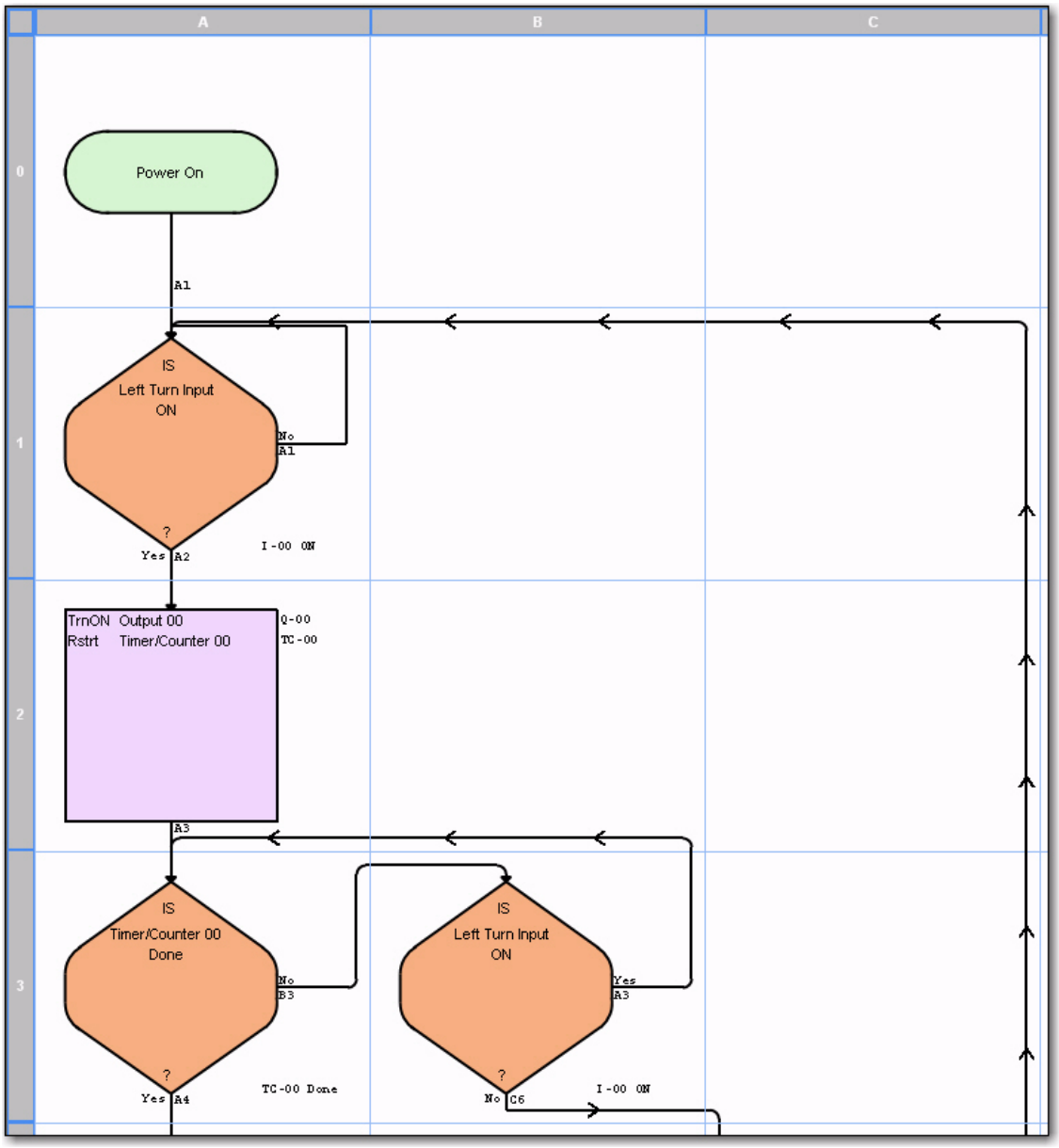

Figure 8-20 Completed "LeftTurn" flow chart (top half)

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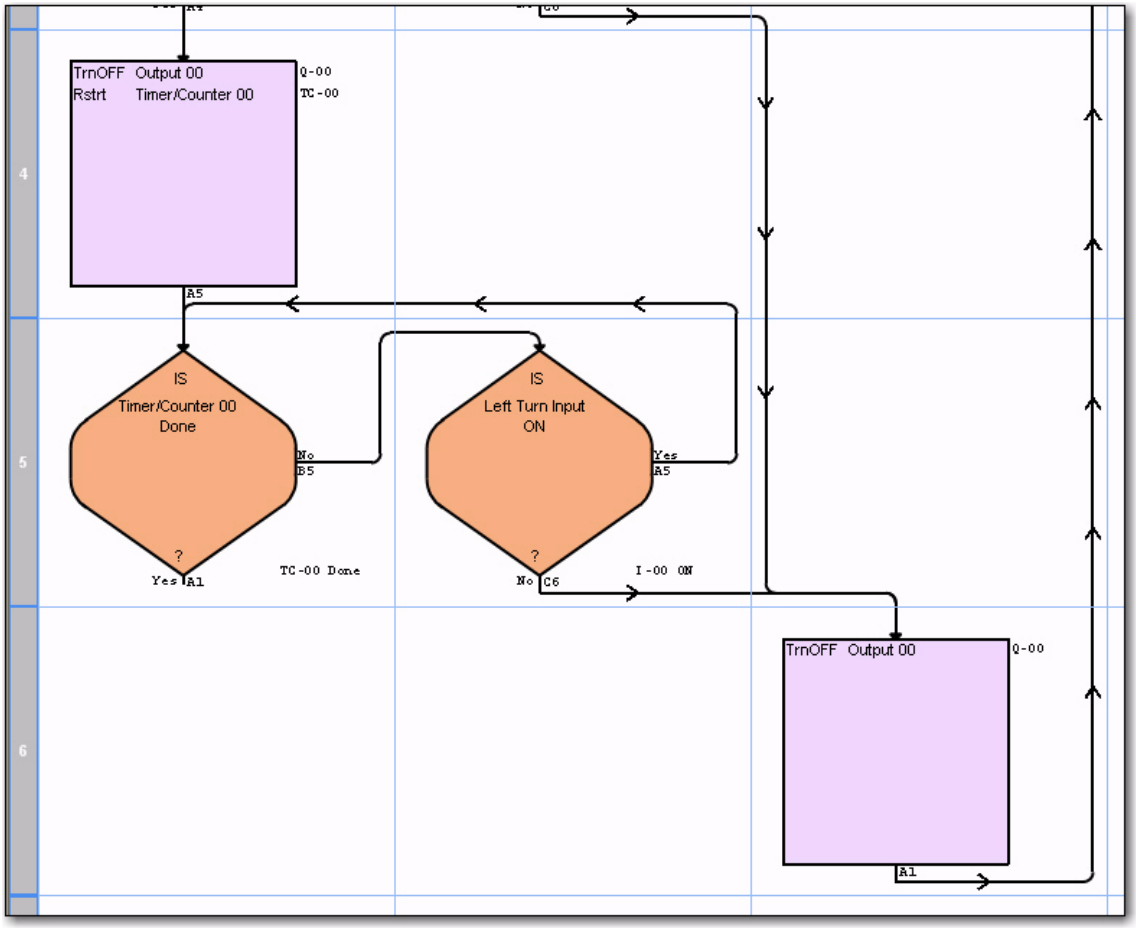

Figure 8-21 Completed “LeftTurn” flow chart (bottom half)

Manually Creating Flow Lines

If any automatic routing decisions that nanoNavigator makes aren’t adequate, delete the flow line and manually create a new one. For example, if the route from C6 to A1 is confusing, do the following:

1. Select the line by clicking anywhere along it. When selected, the line highlights (red by default).
2. Press the <Delete> key to delete the line.
3. Click the exit region of block C6, and notice that a grid of light-colored (orange by default) squares appear (nine per cell).
4. Click the square in the lower-right corner of cell C6.
5. If necessary, scroll up to view row 2.
6. Click the square in the lower-right corner of cell C0.
7. Click the square in the center-bottom of cell A0.
8. Click the top of the Decision block in A1 to complete the flow line.

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Displaying Output – Creating Messages

To view what the project is doing, it is easy to set up messages to display on the optional nanoLC Operator Panel. If the nanoLC does not include an Operator Panel, this section may still be worthwhile to see how operators can interact with the display and keys. To create the display flow chart program, follow these steps:

1. Select the “View... Data Items” menu to display the Data Item Editor.
2. Click the plus button in front of “Display Messages” to view the 31 available message items.
3. Change the message item “Label” and “Type” for the first nine message items as shown in Table 8-4.

“Type” refers to the input type expected in response to a displayed message. The operator provides input via nanoLC Operator Panel keys.

Table 8-4 Message Data Items

Data Item	Label	Type
M-00	Background	Time of Day
M-01	LeftTurnOff	
M-02	LeftTurnOn	
M-03	RightTurnOff	
M-04	RightTurnOn	
M-05	LeftBrakeOff	
M-06	LeftBrakeOn	
M-07	RightBrakeOff	
M-08	RightBrakeOn	

4. Select the “View... Messages” menu to open the Message Editor. The Message Editor defines messages that a control program can write to the optional Operator Panel. Messages may also define inputs that the operator needs to provide via the built-in Operator Panel keys.
5. Leave the first line of the message blank, and leave the “Clear Line” check box selected (selected by default) for line 1.

When a flow chart program executes a Message block, the entire message is written to the display. Only pixels specifically highlighted get written. The “Clear Line” check box (selected by default) causes the nanoLC to clear the entire line before writing the new data to the display. For more information about the Message Editor, see “Using the Message Editor” on page 3-31.

6. In the second and third line, enter the letters “nano” centered (beginning with the ninth pixel). Clear the “Clear Line” check box for both lines\.
7. In the fourth line, position the highlighted box in the eleventh position, and then use the “Insert Data Entry Item” group to do the following:
   - Use the “Return Type” drop-down list to select “Time of Day”.
   - Click the “Insert” button.

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8. The message should look like Figure 8-22. Click the “Save” button.

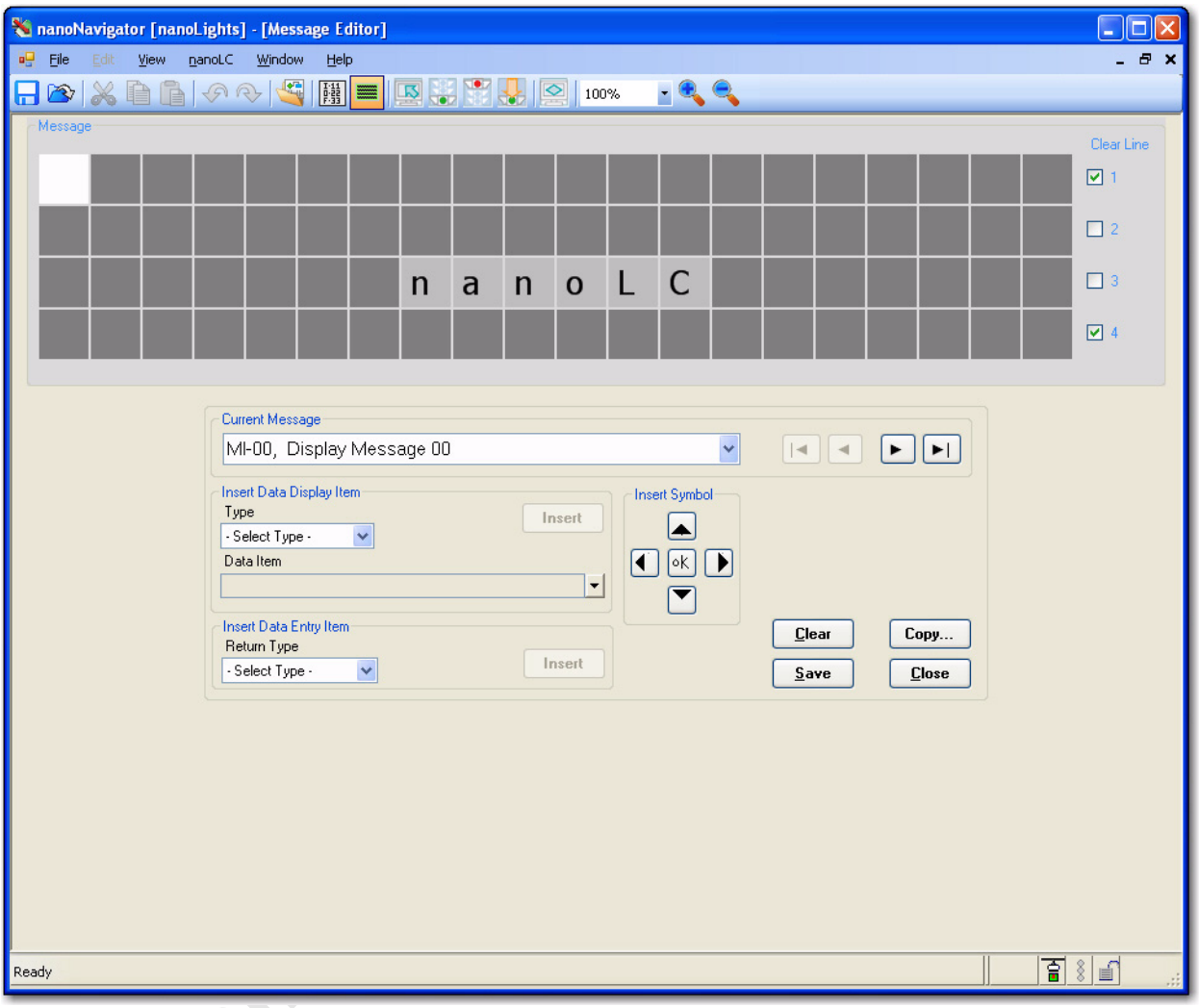

Figure 8-22 Message M-00, Background

9. Use the “Current Message” drop-down list to select “M-01, LeftTurnOff”.
10. Leave the first and fourth lines blank, and clear the “Clear Line” check boxes (selected by default).

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11. In the second and third lines, enter a “space” in the first three pixels. Figure 8-23 shows the resulting Message Editor.

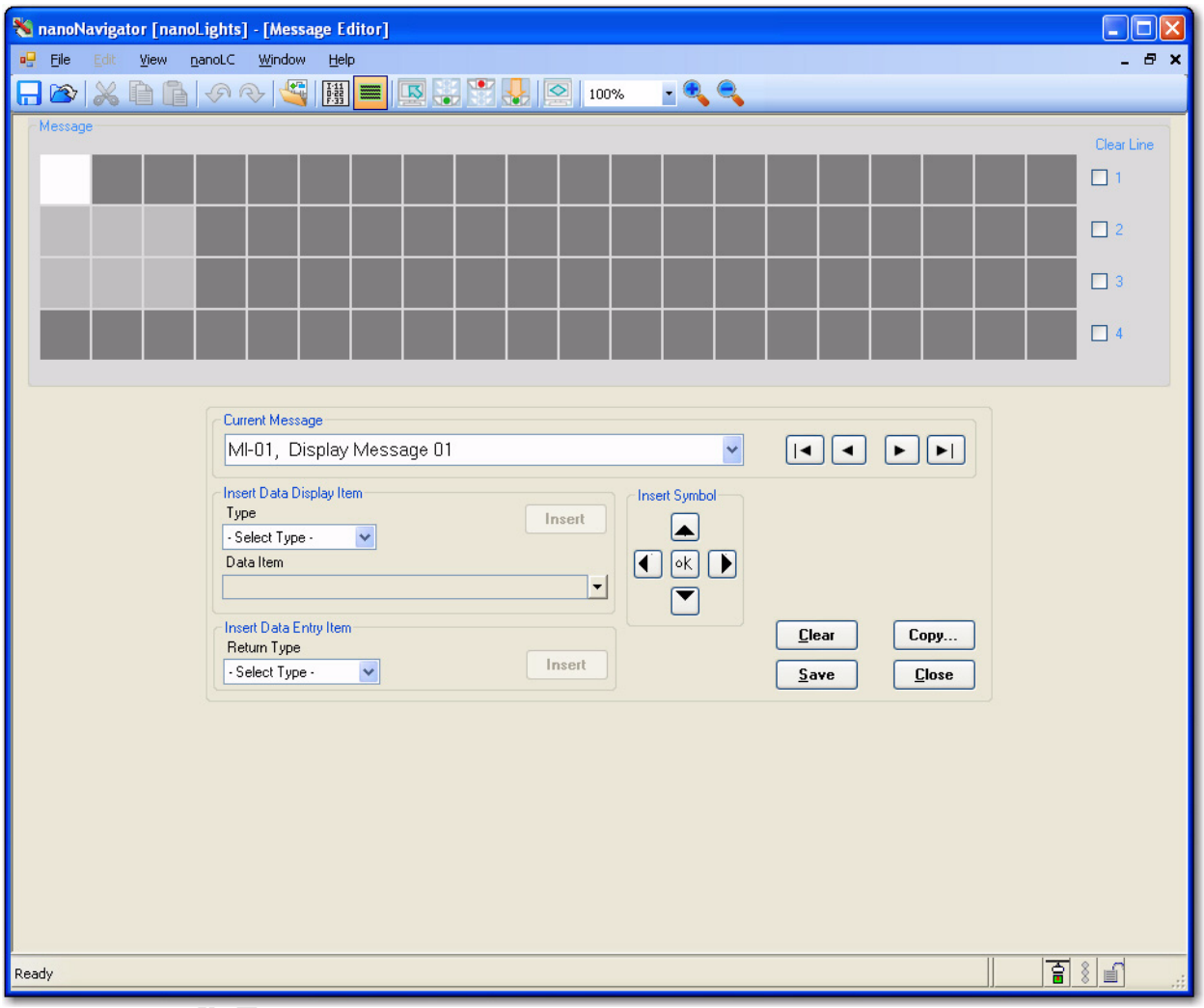

Figure 8-23 Message M-01, LeftTurnOff

12. Click the “Save” button.
13. Use the “Current Message” drop-down list to select “M-02, LeftTurnOn”.
14. Leave the first and fourth lines blank, and clear the “Clear Line” check boxes (selected by default).

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15. In the second and third lines, use the “Insert Symbol” keys to enter a the left-pointing arrow in the first three pixels. Figure 8-24 shows the resulting Message Editor.

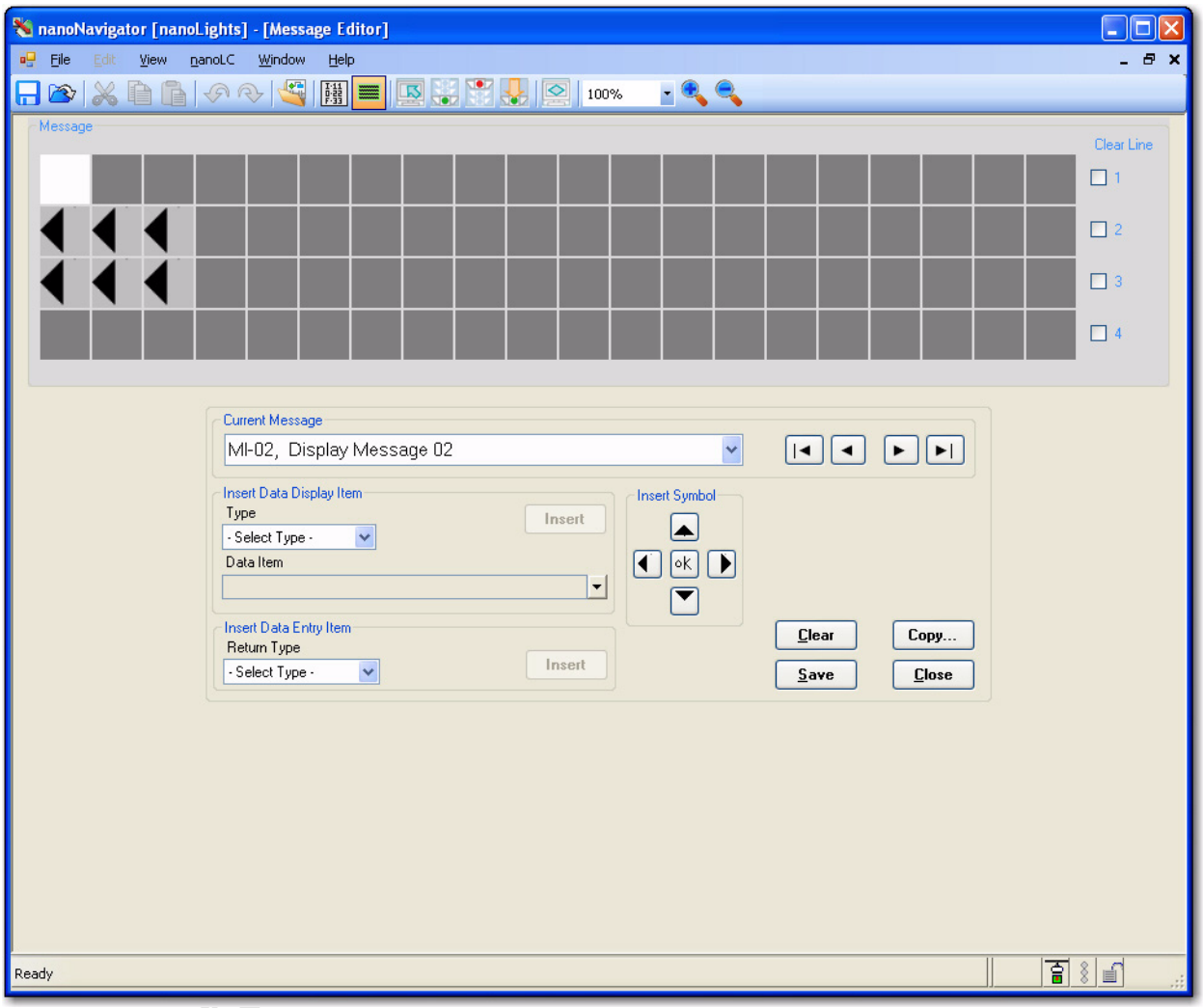

Figure 8-24 Message M-02, LeftTurnOn

16. Follow the same procedure to create the “RightTurnOff” and “RightTurnOn” messages with right-pointing arrows on the right side of the message display.
17. Follow similar procedures to create the “LeftBrakeOff” and “RightBrakeOff” messages. For “LeftBrakeOff” message, enter the “space” keys in the fifth through seventh pixels in the second and third lines. For the “RightBrakeOff” message, use the fifth through seventh pixels counting from the right-side of the display.

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18. Follow similar procedures to create the “LeftBrakeOn” and “RightBrakeOn” messages. For “LeftBrakeOn” message, enter the up-arrow symbol key in the fifth through seventh pixels in the second line and the down-arrow symbol key in the same pixels in the third line. For the “RightBrakeOn” message, use the fifth through seventh pixels counting from the right-side of the display. Figure 8-25 shows the resulting Message Editor.

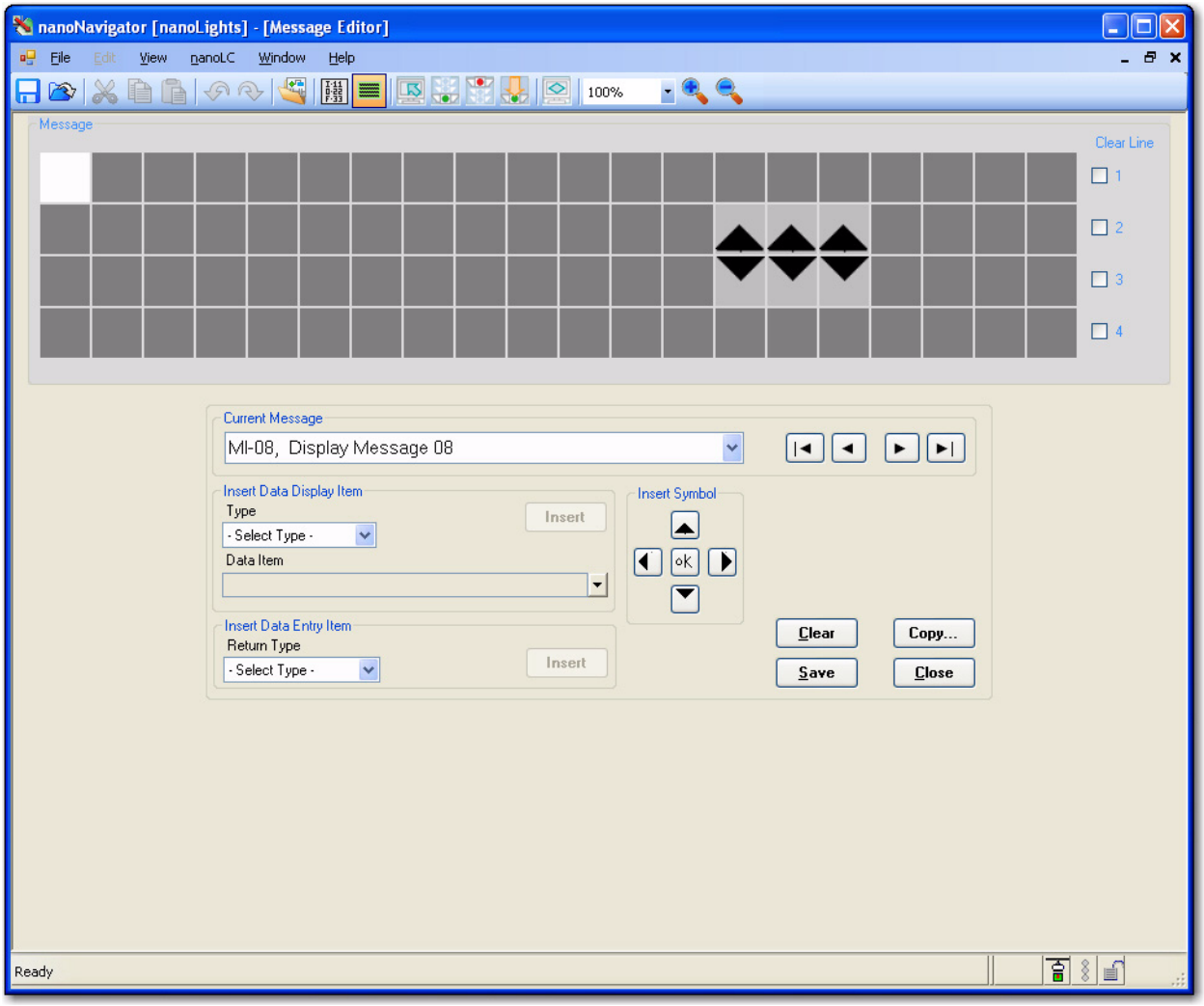

Figure 8-25 Message M-08, RightBrakeOn

Displaying Messages – Creating the Flow Chart

After defining messages, create a flow chart that displays appropriate messages depending on the state of data items during project execution.

1. Create a new flow chart.
2. In cell A1, enter a Message block.
3. Double-click the Message block and select the message, “M-00 Background” as the “Message #”.
4. Enter a Decision block in the following cells: A2, B2, C2, and D2.
5. Enter a Control block in the following cells: A3, B3, C3, and D3.

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6. Enter the expressions and connect the blocks as shown in Figure 8-26.

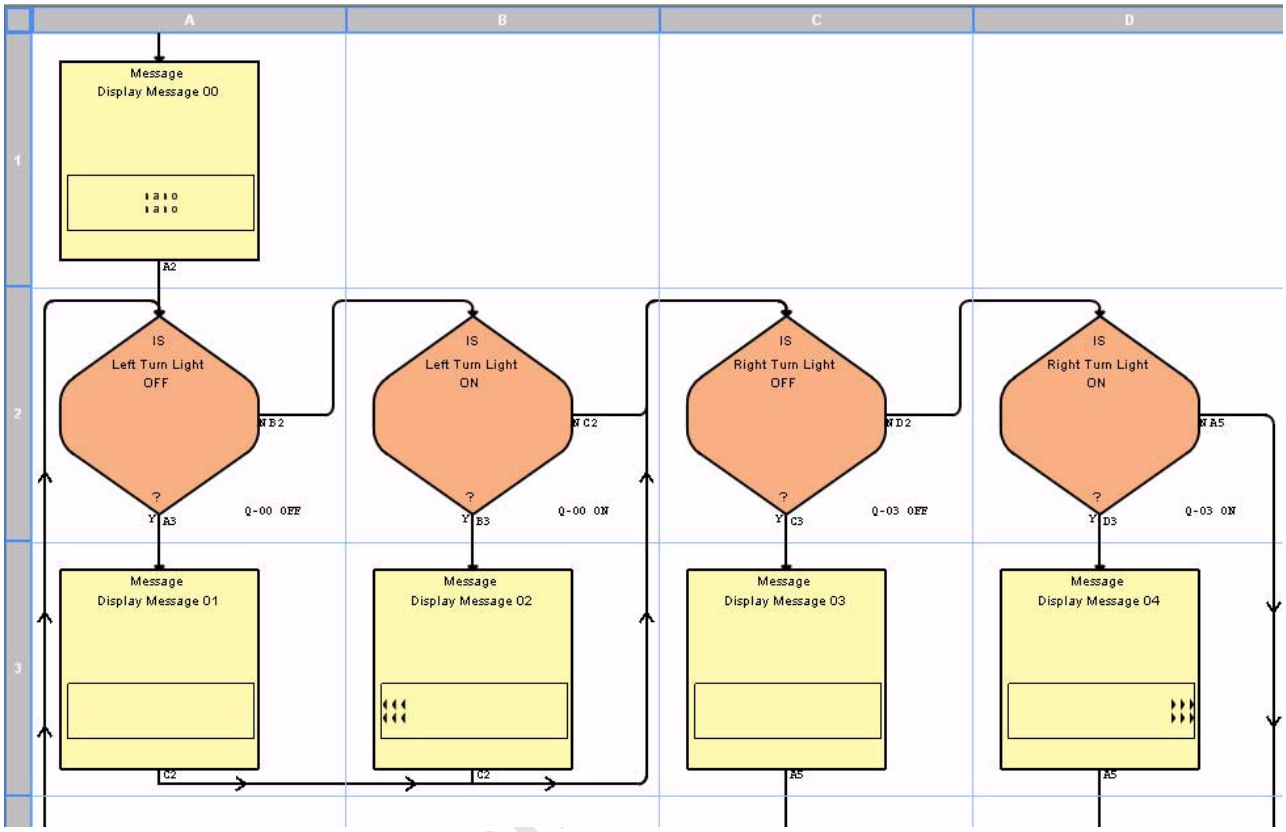

Figure 8-26 The top half of the display flow chart

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7. Complete the bottom half of the flow chart as shown in Figure 8-27.

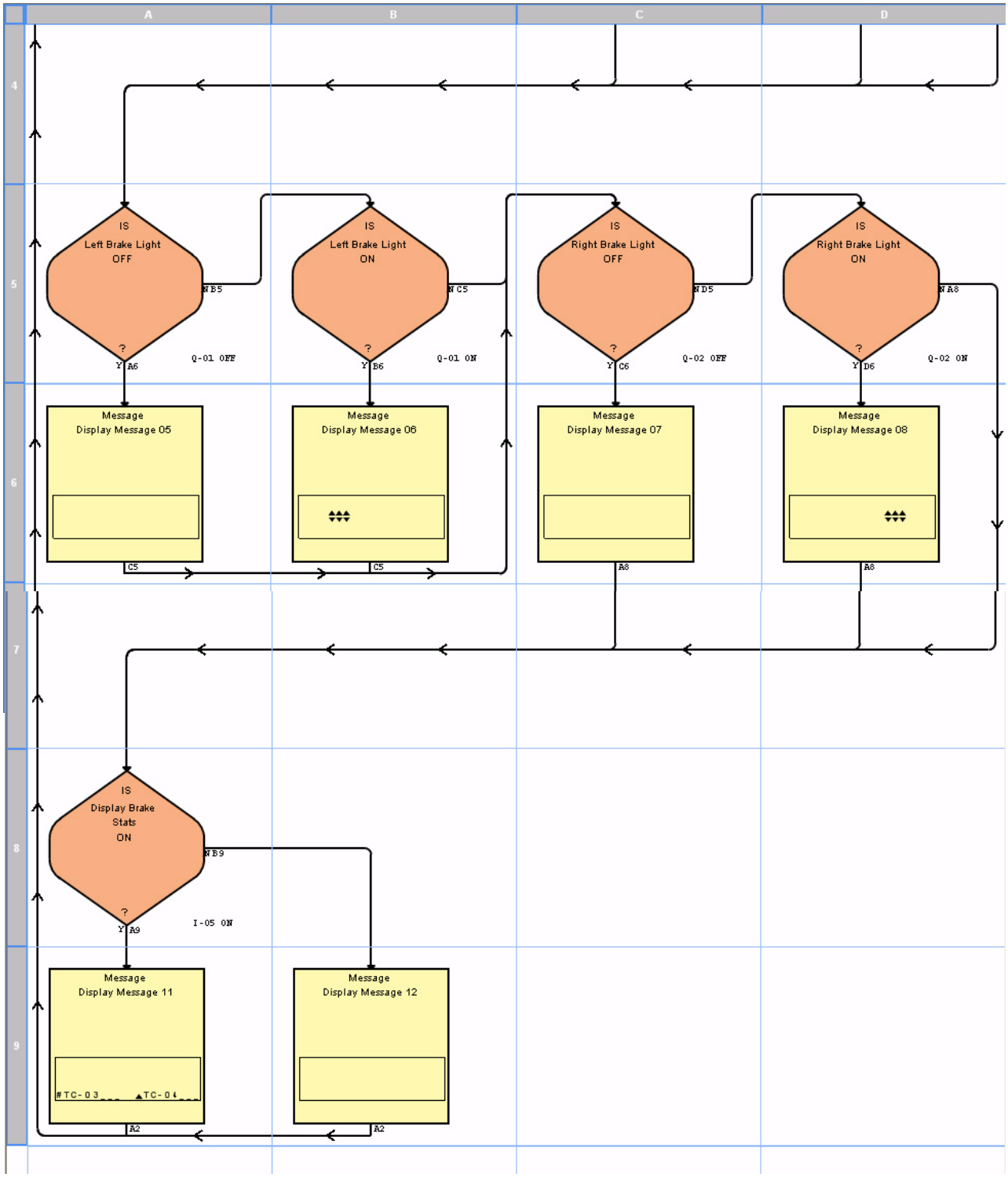

Figure 8-27 The bottom half of the display flow chart.

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8. Connect the flow from the exit of the Message blocks in cell A9 and B9 to the input of the Decision block at cell A2.
9. Save the flow chart with the name “Display”.

At this point, it is time to begin verifying the project. It is good programming practice to verify modules one at a time rather than waiting until all the flow charts in the project are ready.

In this case, verifying could have begun with part of the Display flow chart and either the BrakeControl or LeftTurn flow charts finished. For this tutorial, however, working on both BrakeControl and LeftTurn prior to writing the complete Display flow chart provided more experience with flow charting and the Flow Chart Editor.

To verify the project in its current state, go forward to “Downloading and Verifying the Project” before returning to “Completing the Project”.

Completing the Project

As an exercise, create a RightTurn flow chart and a Hazard flow chart using concepts learned. Use the LeftTurn flow chart as an example of what is required.

8.5 Downloading and Verifying the Project

After completing the project, or enough of it to begin verifying, save the project (use the “File... Save Project” menu). Then, there are two choices for verifying:

– Download the project to a connected nanoLC and verify it there.
– Connect and verify the project using the simulator.

The following sections go through both options.

8.5.1 Downloading the Project

Downloading a project to a connected nanoLC is simple. Follow these steps:

1. If nanoNavigator is not connected to the nanoLC, follow the instructions in “Connecting to a nanoLC” on page 2-13.
2. Do one of the following:
   – Select the “nanoLC... Download”. nanoNavigator automatically makes the logical connection to the nanoLC. Click the “OK” button in the message dialog box.
   – Select the “nanoLC... Download & Go” menu. nanoNavigator automatically makes the logical connection to the nanoLC and begins execution after downloading the project.

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That's it, unless nanoNavigator detects an error while preparing the download. If an error occurs, nanoNavigator displays the "Project Information... Messages" tab with a list of messages nanoNavigator creates as it verifies the project.

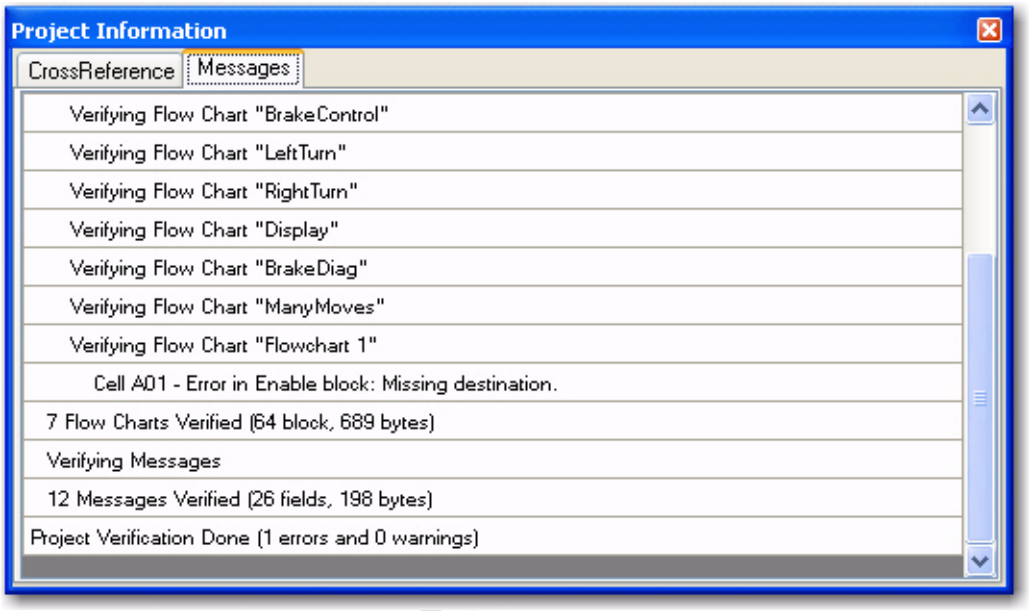
Project Information
CrossReference
Messages
Verifying Flow Chart "BrakeControl"
Verifying Flow Chart "LeftTurn"
Verifying Flow Chart "RightTurn"
Verifying Flow Chart "Display"
Verifying Flow Chart "BrakeDiag"
Verifying Flow Chart "ManyMoves"
Verifying Flow Chart "Flowchart 1"
Cell A01 - Error in Enable block: Missing destination.
7 Flow Charts Verified (64 block, 689 bytes)
Verifying Messages
12 Messages Verified (26 fields, 198 bytes)
Project Verification Done (1 errors and 0 warnings)

Figure 8-28 The "Project Information... Messages" tab with error information

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Simulator Button

8.5.2 Connecting to the Simulator

To simulate a project, select the “nanoLC... Simulate Project” menu or click the “Simulator” button on the standard toolbar. This displays the “nanoLC Monitor” window. If a flow chart is open when started, the simulator displays all the data items referenced in that flow chart.

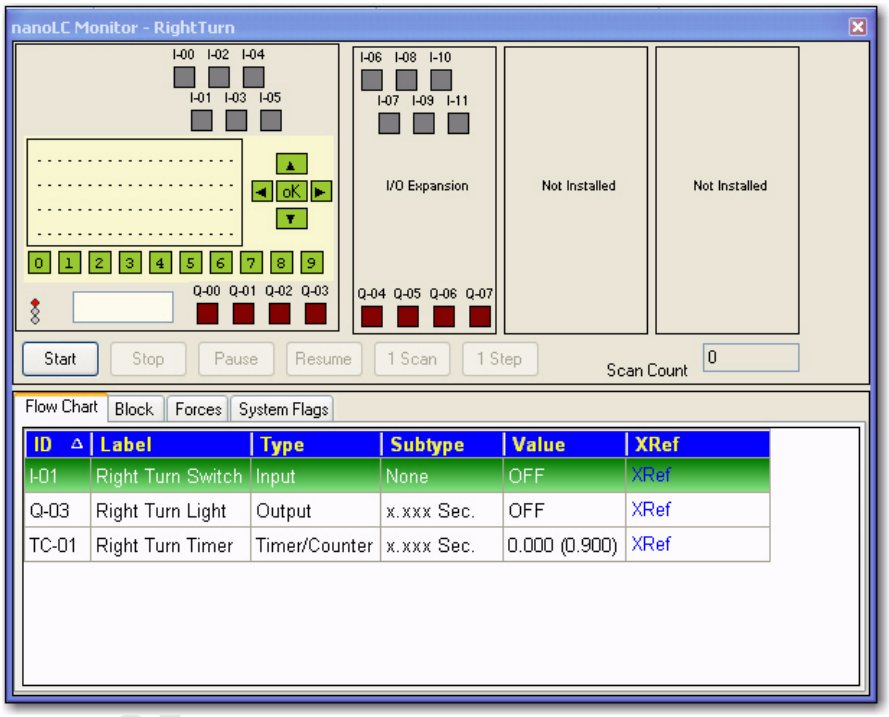

Figure 8-29 Simulator with data items displayed

To begin simulation, click the “Start” button. Table 8-5 lists the buttons used to control the nanoLC simulator.

Table 8-5 Simulator buttons

Button	Description
Stop	Stops the currently executing project. Click the “Start” button to restart the project from the beginning.
Pause	Pause the currently executing project. Click the “Resume”, “1 Scan”, or “1 Step” to resume project execution from the point where it was paused.
Resume	Resumes a paused project.
1 Scan	Resumes a paused project for one complete scan.
1 Step	Resumes a paused project for execution of one block in each currently executing flow chart.

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Monitoring Execution in the Simulator

The monitoring features of the simulator are the same as those available for monitoring a project executing on a nanoLC. For a description of how to monitor, cross-reference, and force data items, see “Monitoring the Project” on page 8-42. That section also describes execution tracking in FlowView.

Additional Simulator Features

The top of the simulator window (see Figure 8-29) has buttons that you can click to simulate operator input. The buttons are labeled “0” through “9”, plus the four arrow and “OK” buttons. There are additional squares (initially gray colored) that simulate inputs to the base unit and any configured I/O Expansion modules. To simulate input do one of the following:

– Clicking one of the inputs turns it green for as long as you hold the mouse button.
– Right-clicking one the inputs turns it green and latches it ON. Right-click again to turn it OFF.

Simulated outputs appear as dark red squares when the output is OFF and bright red when the output is ON. In addition, there is an area of the simulator that mimics any outputs to the optional LCD. Figure 8-30 shows the simulator with the “Brake Switch” data item turned ON.

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The result is that the LCD mimics brake lights on both sides of the vehicle and the outputs Q-01 and Q-02 are ON. The green flow chart elements show the current execution path in the BrakeControl flow chart.

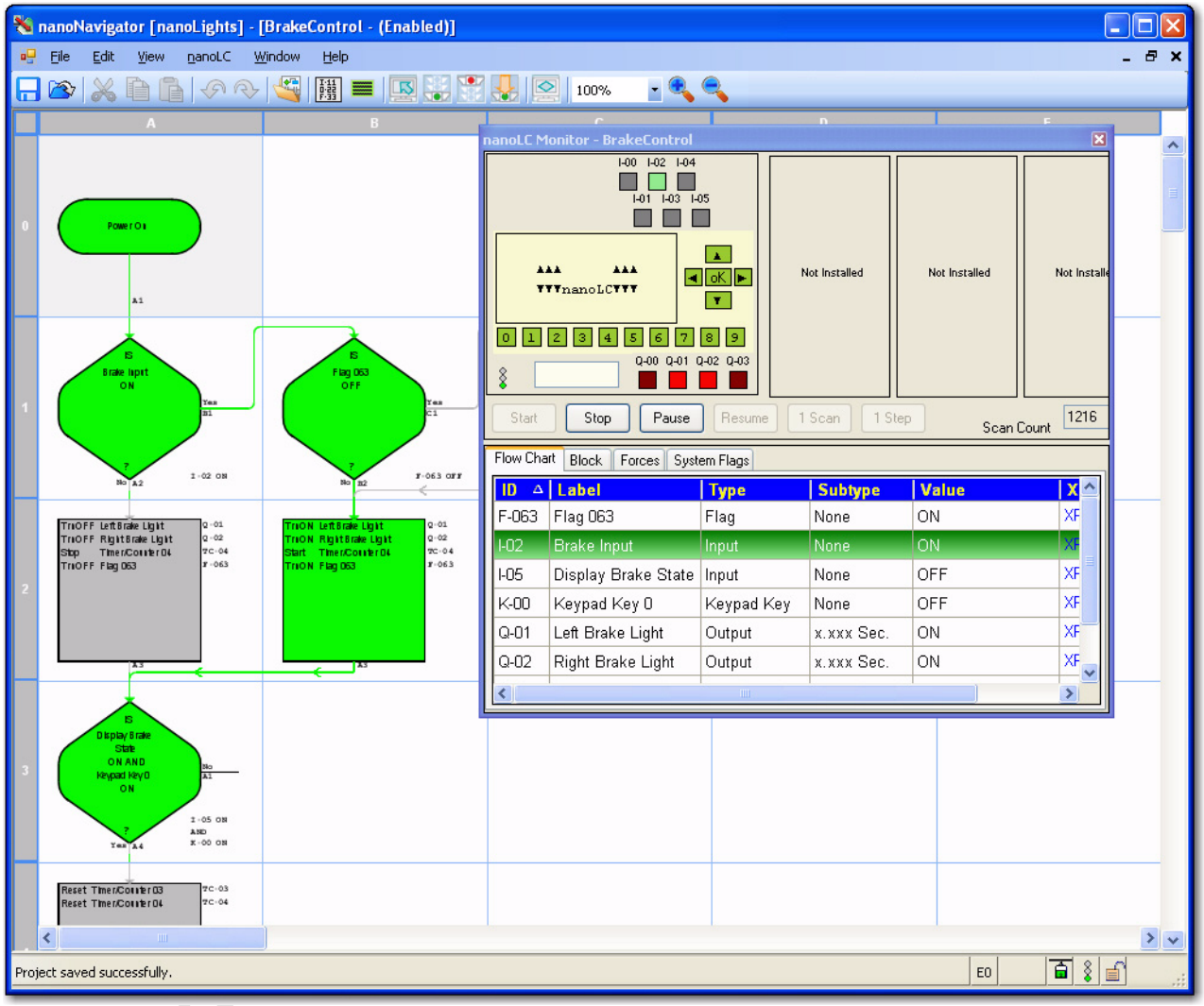
nanoNavigator [nanoLights] - [BrakeControl - (Enabled)]
File Edit View nanoLC Window Help
100%
nanoLC Monitor - BrakeControl
I-00 I-02 I-04
I-01 I-03 I-05
nanoLC
OK
Not Installed
Not Installed
Not Installe
0 1 2 3 4 5 6 7 8 9
Q-00 Q-01 Q-02 Q-03
Start Stop Pause Resume 1 Scan 1 Step
Scan Count 1216
Flow Chart Block Forces System Flags
ID Label Type Subtype Value
F-063 Flag 063 Flag None ON
I-02 Brake Input Input None ON
I-05 Display Brake State Input None OFF
K-00 Keypad Key 0 Keypad Key None OFF
Q-01 Left Brake Light Output x.xxx Sec. ON
Q-02 Right Brake Light Output x.xxx Sec. ON
Power On
IS Brake Input ON
IS Flag 063 OFF
TriOFF Left Brake Light
TriOFF Right Brake Light
Stop Timer/Counter 04
TriOFF Flag 063
TriON Left Brake Light
TriON Right Brake Light
Start Timer/Counter 04
TriON Flag 063
IS Display Brake State ON AND Keypad Key 0 ON
Reset Timer/Counter 03
Reset Timer/Counter 04
Project saved successfully.

Figure 8-30 Simulation of the nanoLights project

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8.5.3 Monitoring the Project

Once nanoLC has a project downloaded to it, nanoNavigator can start, stop, and monitor its execution by viewing flow charts and data items. nanoNavigator can even modify data items, inputs, and outputs.

Start Monitoring Button

To monitor the project, follow these steps:

1. Select the “nanoLC... Run” menu.
2. Select the “nanoLC... Start Monitoring” menu or click the “Start Monitoring” button on the Main toolbar. This displays the “nanoLC Monitor” window (see Figure 8-31). For more information about this window and how to use it, see “nanoLC Monitor Window” on page 7-4.

When attempting to monitor a stopped project, nanoNavigator provides the opportunity to automatically begin execution on the nanoLC.

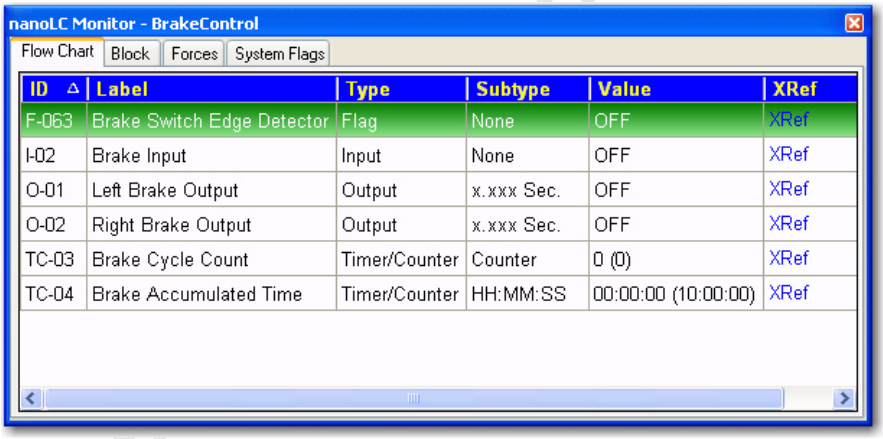

Figure 8-31 The “nanoLC Monitor... Flow Charts” tab

The “nanoLC Monitor... Flow Charts” tab displays the status of all data items in the current flow chart. For more information, see “Charts Tab” on page 7-4.

Select any block in the flow chart to display data item values in that block. This also brings the “nanoLC Monitor... Blocks” tab to the front. For more information, see “Block or Element Tab” on page 7-6.

Execution Tracking

Use nanoNavigator to view the execution track of any flow chart in the project. In Monitor mode, open flow charts automatically provide execution tracking. Execution tracking is the display of color-coded blocks to indicate whether or not blocks were recently executed. The color coding is:

– Green: Always executed on every scan
– Yellow: Sometimes executed
– Gray: Never executed

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When entering Monitor mode, nanoNavigator continues to display whatever is in the workspace. To open a chart, use the Chart Explorer. To do this:

1. Select the “View... Chart Explorer” menu to display the Chart Explorer. In Monitor mode, the Chart Explorer has two additional columns of information. The first gives the status of each chart (enabled, waiting), the second provides the cell and type of block that last executed at the end of the most recent scan.

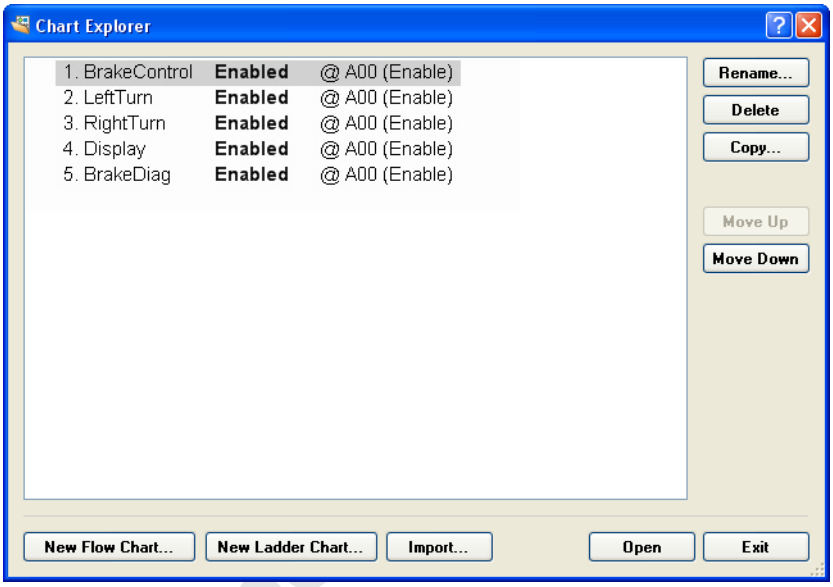

Figure 8-32 The Chart Explorer

2. Either double-click one of the charts in the list, or select a chart and click the “Open” button at the bottom of the window. In either case, the chart opens.

Alternatively, select the “File... Open Chart...” menu, and then select a flow chart from the cascade menu.

8.5.4 Verifying a Project

In addition to viewing flow charts with their execution track and data item values as they change dynamically, nanoNavigator can force data values to cause flow chart execution to take different paths. Another important tool to verify and correct projects is the ability to cross-reference all locations where a data item appears in the project. This section shows how to use these two important tools.

Forcing Data Items

nanoNavigator can force input, output, and flag data items. When a data item has a forced value, the value won’t change due to different input states or under program control. This provides a valuable capability to verify a project.

Be sure to remove all forces before running a project in a production environment.

Use the “nanoLC Monitor” window (see Figure 8-31 on page 8-42) to force data item values with either the “Flow Charts” or “Blocks” tab. To force a data item value, follow these steps:

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1. With the project running and in Monitor mode, view the “nanoLC Monitor” window.
2. Using either the “Flow Charts” or “Blocks” tab, right-click anywhere in the row of the data item to force.

   Table 8-6 list the force options available depending on the type of data item.

Table 8-6 Force options available depending on data item type

Type of Data Item	Setting	Description
Input	Force ON	Sets the Input bit ON (see “Forcing Data Values” on page 7-7).
	Force OFF	Sets the Input bit OFF (see “Forcing Data Values” on page 7-7).
	UnForce	Removes Force setting.
Outputs and Flags	Turn ON	Sets the output or flag bit ON. The value can change under program control.
	Turn OFF	Sets the output or flag bit OFF. The value can change under program control.
	Force ON	Sets the output bit or flag ON (see “Forcing Data Values” on page 7-7).
	Force OFF	Sets the output bit or flag OFF (see “Forcing Data Values” on page 7-7).
	UnForce	Removes Force setting.
Registers and Timer/Counters	Set Value	Displays a pop-up dialog box that permits setting a value for the register or timer/counter.
	Zero Value	Sets the register or timer/counter to zero.

Using the “nanoLC Monitor... Forces” tab permits viewing all forced items.

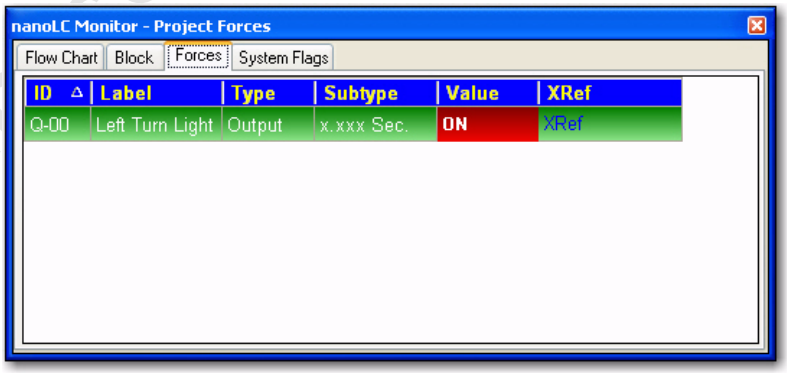

Figure 8-33 The “nanoLC Monitor... Forces” tab

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Cross-Referencing Data Items

Cross-referencing data items is an important tool to use when verifying a project. Examples of when to use cross-references:

– While monitoring a data item, the value changes unexpectedly
– When intending to force a data item and wanting to identify everywhere the data item is used
– Changing a flow chart and impacting a data item... wanting to identify everywhere the data item is used

To cross-reference a data item, follow these steps:

1. With the project running and in Monitor mode, view the “nanoLC Monitor” window.
2. Using either the “Flow Charts” or “Blocks” tab, click the “XRef” hyperlink. This displays the “Project Information... Cross-Reference” tab.

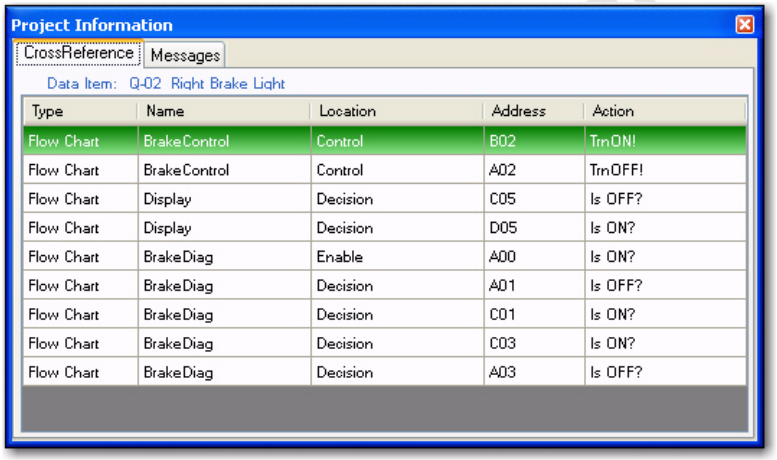
Project Information
CrossReference
Messages
Data Item: Q-02 Right Brake Light
Type Name Location Address Action
Flow Chart BrakeControl Control B02 TrnON!
Flow Chart BrakeControl Control A02 TrnOFF!
Flow Chart Display Decision C05 Is OFF?
Flow Chart Display Decision D05 Is ON?
Flow Chart BrakeDiag Enable A00 Is ON?
Flow Chart BrakeDiag Decision A01 Is OFF?
Flow Chart BrakeDiag Decision C01 Is ON?
Flow Chart BrakeDiag Decision C03 Is ON?
Flow Chart BrakeDiag Decision A03 Is OFF?

Figure 8-34 The “Project Information... Cross-Reference” tab

The “Project Information... Cross-Reference” tab displays all locations that reference or modify the selected data item. The “Type” is either “Flow Chart” or “Message”.

To quickly access any listed reference, double-click anywhere in the row. nanoNavigator automatically opens the flow chart or Message Editor and displays the address.

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A Technical Appendix – Setting Preferences

This section is for advanced users who are interested in customizing the appearance of nanoNavigator. If satisfied with the default colors, fonts, and font sizes, there is no need to modify any of the preferences.

The “File... Preferences...” menu displays the multi-tab ”Preferences” dialog box. Each tab provides a set of options that configures how nanoNavigator appears on the screen. The following sections describe each tab of the “Preferences” dialog box.

A 1 General Tab

The “Preferences... General” tab (see Figure A-1) permits specification of options for the Toolbar, Chart Explorer window, and Message Editor.

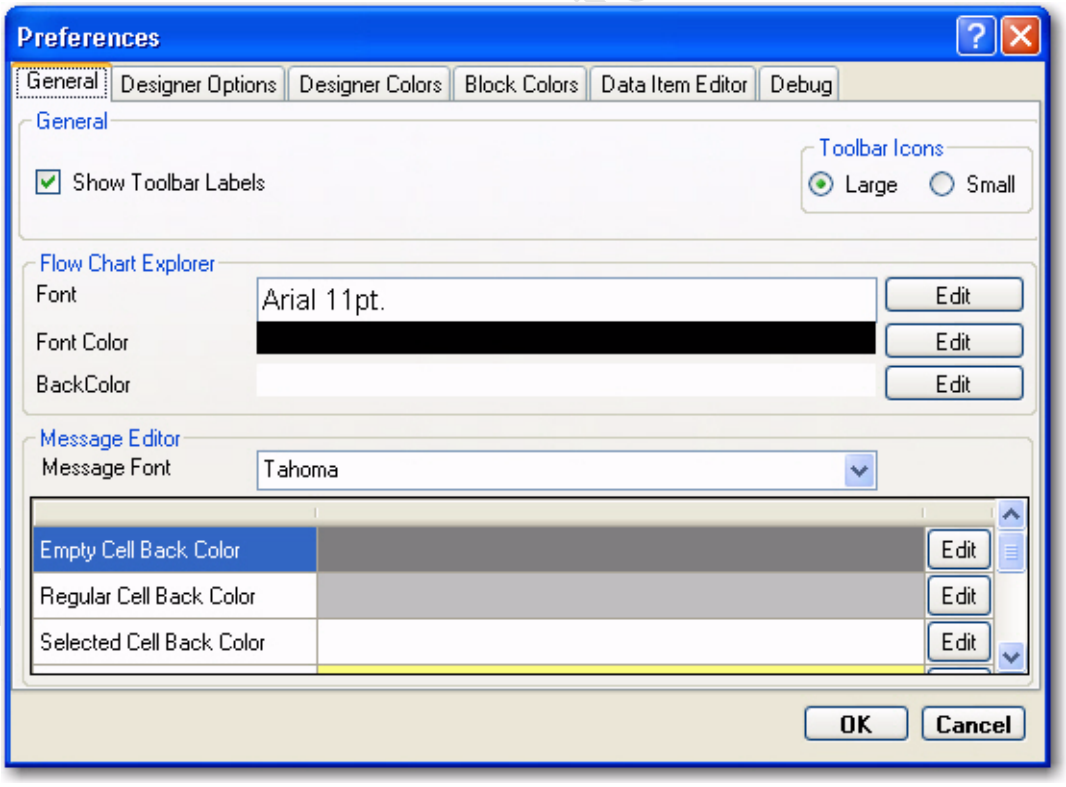

Figure A-1 “Preferences... General” tab

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A 1.1 Block Toolbar Options

This group provides the following options:

– "Show Toolbar Labels" – Select this check box to have labels appear under toolbar buttons (the default). Clear the check box to remove the labels.

– "Toolbar Icons" – Select either large or small buttons by selecting the corresponding radio button.

A 1.2 Chart Explorer

The options in this group permit modification of text font, size, style, and color, as well as the background color used for the Chart Explorer. Click the corresponding "Edit" button to modify current settings. The "Edit" buttons associated with font selection display a standard font selection dialog box. The "Edit" buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see "Designer Colors Tab" on page A-5.

A 1.3 Message Editor

The options in this group permit modification of text font, size, style, and color, as well as the background color used for the Message Editor. Click the corresponding "Edit" button to modify current settings. The Edit" buttons associated with font selection display a standard font selection dialog box. The Edit" buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see "Designer Colors Tab" on page A-5.

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A 2 Designer Options Tab

The “Preferences... Designer Options” tab (see Figure A-2) permits specification of various Chart Editor options.

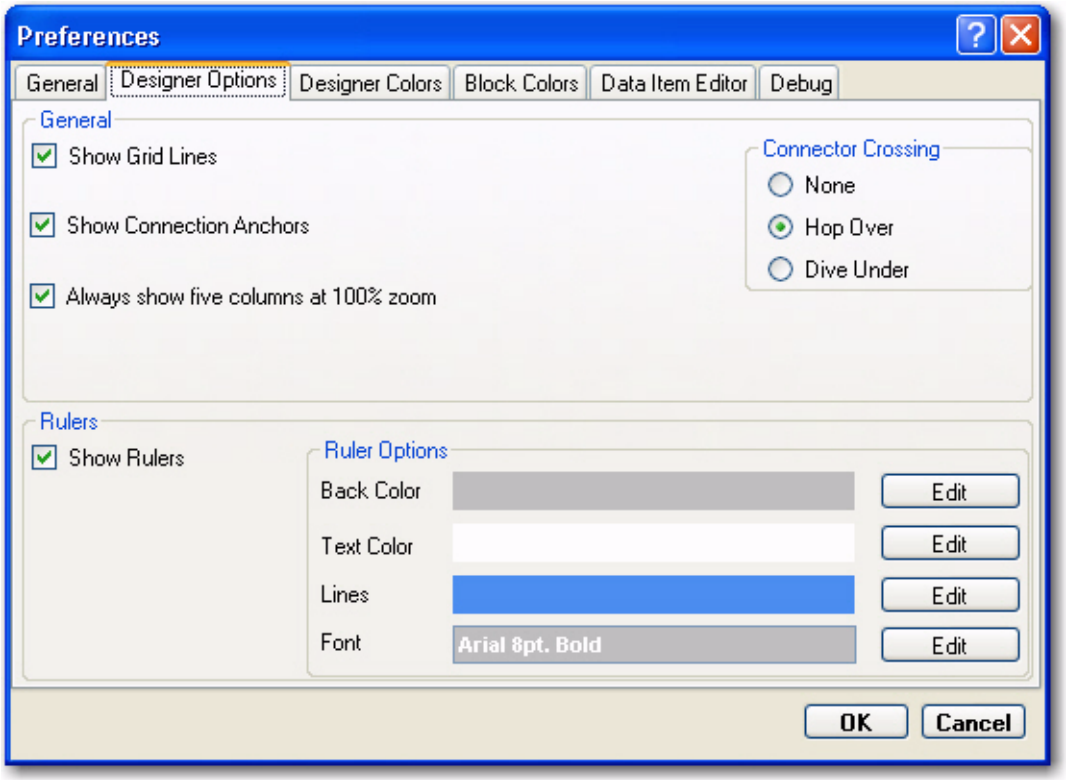

Figure A-2 “Preferences... Designer Options” tab

A 2.1 General

When selected, the options available in the General group do the following:

– “Show Grid Lines” – Displays grid lines in the Chart Editor.

– “Show Connection Anchors” – Displays valid anchor positions on all blocks and in the drawing area when in Connect mode.

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- "Connection Crossing" – This group permits choosing one of the following options for handling connection lines that cross:
  - Select the "File... Open Chart... " menu, and then select a flow chart from the cascade menu.
  - "None" – Crossing lines intersect without special graphic effects.
  - "Hop Over" – One line appears to hop over the other.
  - "Dive Under" – A gap appears in one line to show that it is under the other.
- "Always show five columns at 100% zoom" – When selected, this check box causes the Flow Chart Editor and Ladder Chart Editor to display five columns regardless of the window size.

A 2.2 Rulers

The Rulers group provides the following options:

- "Show Rulers" – Displays horizontal and vertical rulers (column and row labels) along the edge of the drawing area.
- "Ruler Options" – Provides options for background color, text color, line color, and font. The Edit button associated with font selection displays a standard font selection dialog box. The "Edit" buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see "Designer Colors Tab" on page A-5.

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A 3 Designer Colors Tab

The “Preferences... Designer Colors” tab permits selection of default colors for various designer features (see Figure A-3).

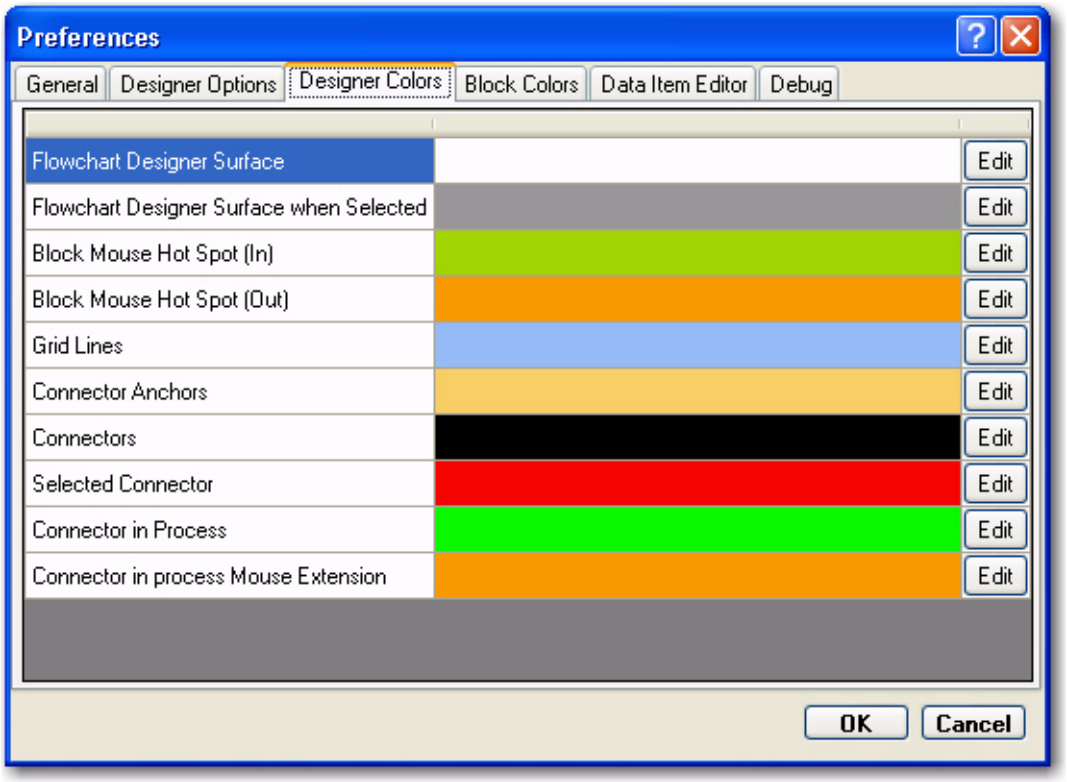

Figure A-3 “Preferences... Designer Colors” tab

To change the color for any feature, click the “Edit” button to display a color picker dialog box with pre-defined colors. For additional color choices, click the “More Colors” link at the bottom of the dialog box to display the “Color” dialog box. This dialog box repeats the basic

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colors, provides quick selection of previously defined custom colors, and provides a “Define Custom Colors” button that expands the “Color” dialog box for custom color definition (see Figure A-4).

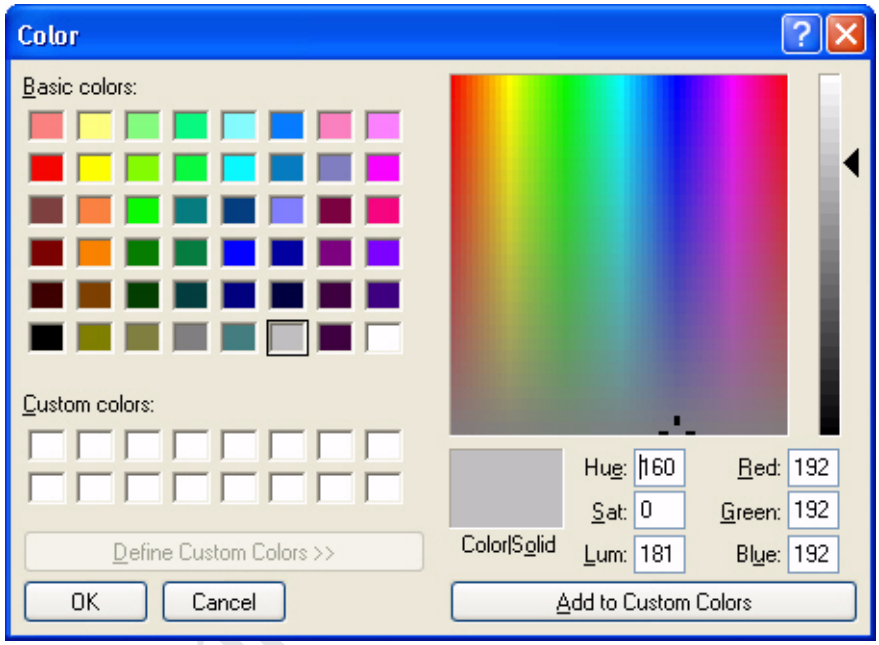

Figure A-4 “Color” dialog box after clicking “Define Custom Color” button

To add a custom color, do one of the following, and then click the “Add to Custom Colors” button:

– Click in the color rectangle to get in the general area of the color of interest, and then use the vertical slide to refine the selection. The rectangle pick selects “Red”, “Green”, “Blue” (RGB) and “Hue”, “Sat” (saturation), and “Lum” (luminosity) values. The vertical slider adjusts the luminosity (and RGB), while holding hue and saturation constant.
– Enter RGB values.
– Enter “Hue”, “Sat”, and “Lum” values.

Once defined, custom colors remain available in the “Color” dialog box until nanoNavigator closes and reopens.

It is possible to add up to 16 custom colors, which appear in the “Custom Colors” squares below the pre-defined “Basic Colors”.

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A 4 Block Colors Tab

Use the “Preferences... Block Colors” tab (see Figure A-5) to define the appearance of flow chart blocks.

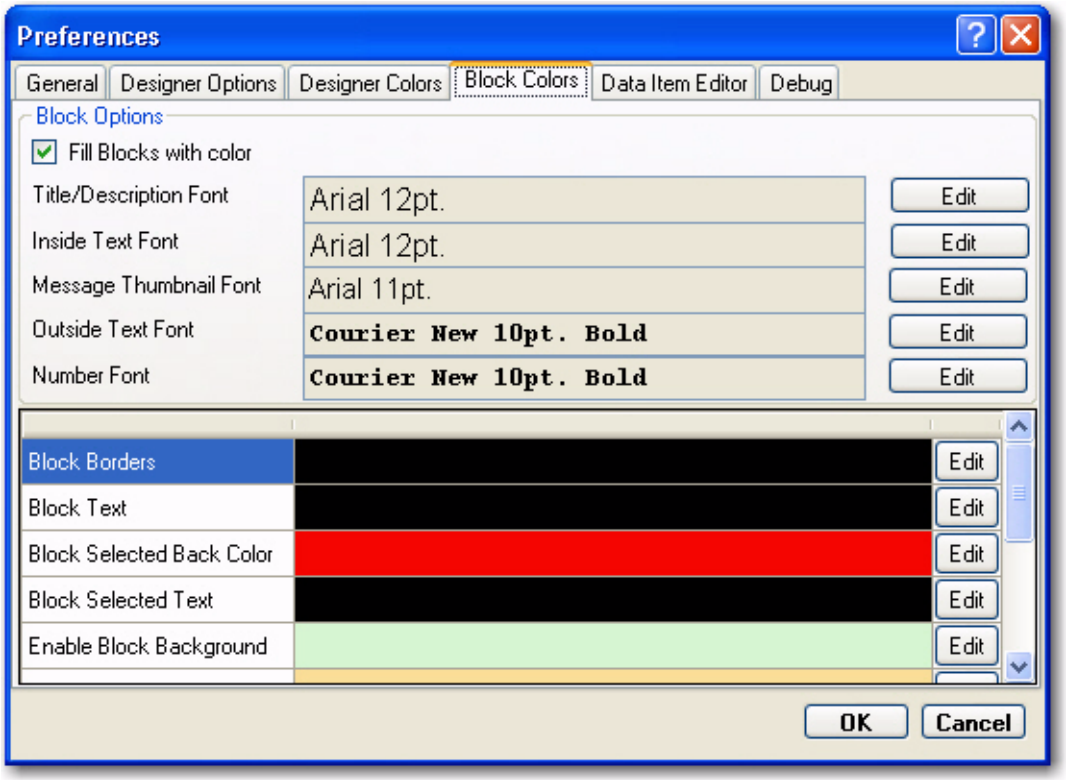

Figure A-5 “Preferences... Block Colors” tab

Select the “Fill Blocks with color” check box to use the color information on this tab. When this box is cleared, all flow chart blocks have a white background. This tab provides options for text and number fonts and colors for block borders, text, selected block, and selected text. There are also separate block fill options for each of the block types. The “Edit” buttons associated with font selections display a standard font selection dialog box. The “Edit” buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see “Designer Colors Tab” on page A-5.

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A 5 Data Item Editor Tab

Use the “Preferences... Data Item Editor” tab (Figure A-6) to define the appearance of the Data Item Editor.

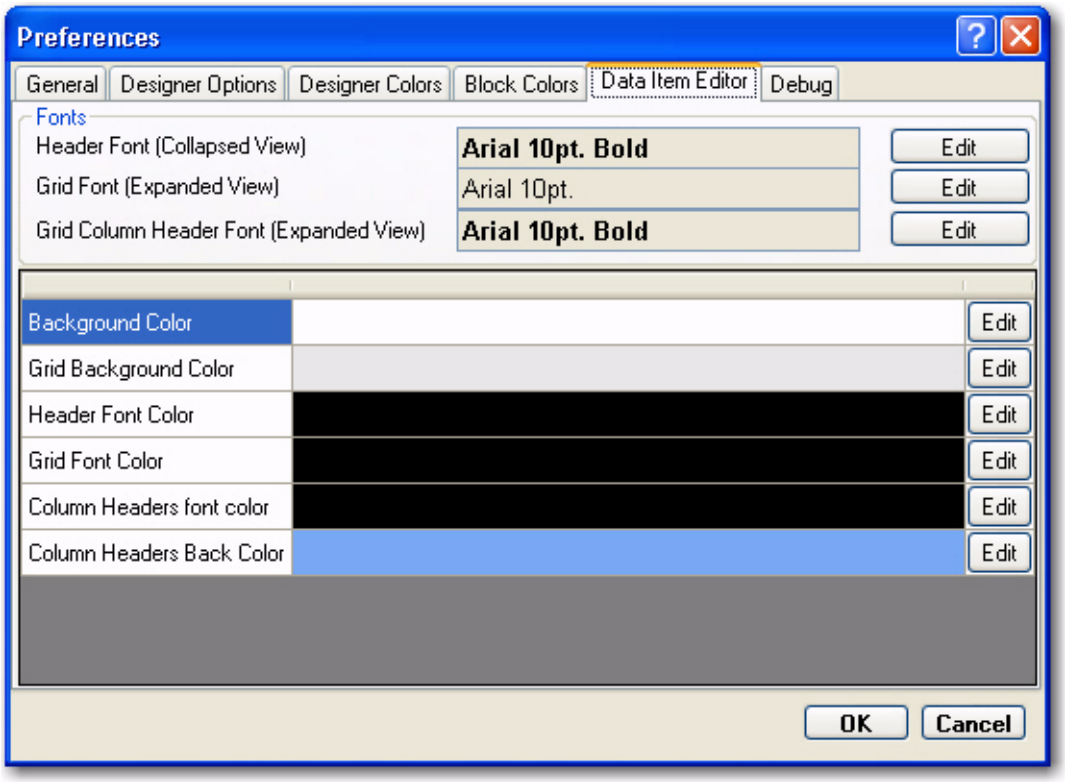

Figure A-6 “Preferences... Data Item Editor” tab

This tab provides options for fonts and colors for the background, grid background, grid font color, and header font and background color. The “Edit” buttons associated with font selections display a standard font selection dialog box. The “Edit” buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see “Designer Colors Tab” on page A-5.

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A 6 Debug Tab

Use the “Preferences... Debug” tab (Figure A-6) to define the appearance of the Flow Chart blocks and forced data item values in the "nanoLC Monitor" window (see “nanoLC Monitor Window” on page 7-4) when monitoring an executing project.

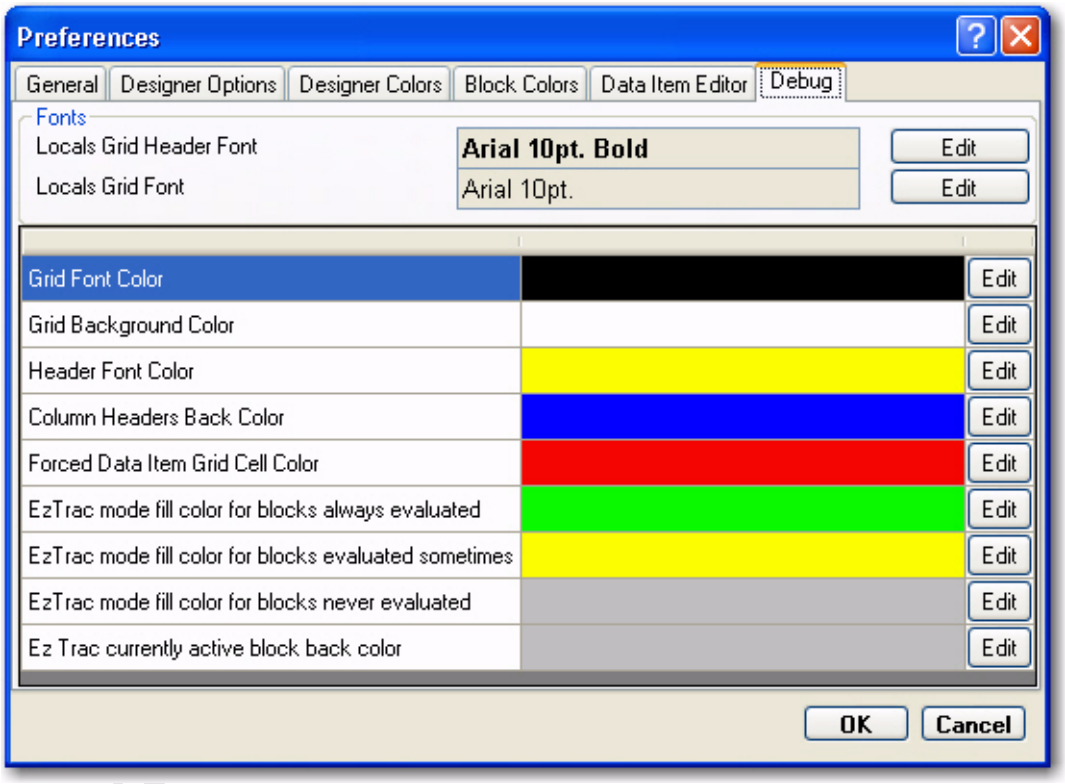

Figure A-7 “Preferences... Debug” tab

This tab provides options for fonts, colors, and grid for the "nanoLC Monitor" window. It also provides options for Monitor mode block colors. The “Edit” buttons associated with font selections display a standard font selection dialog box. The “Edit” buttons associated with color selection display a color picker dialog box. For a description of the ways to use the color picker, see “Designer Colors Tab” on page A-5.

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A 7 Changes Made

The “Changes Made” dialog box (see Figure A-8) appears whenever there are changes to one or more preferences. Click the “OK” button to close the dialog box. This dialog box provides options to specify how to handle changes.

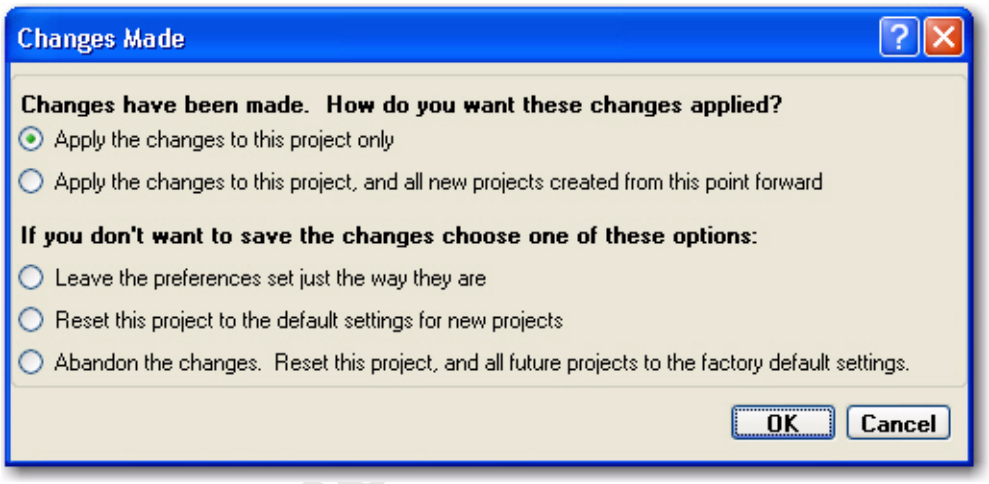
Changes Made
Changes have been made. How do you want these changes applied?
Apply the changes to this project only
Apply the changes to this project, and all new projects created from this point forward
If you don't want to save the changes choose one of these options:
Leave the preferences set just the way they are
Reset this project to the default settings for new projects
Abandon the changes. Reset this project, and all future projects to the factory default settings.
OK
Cancel

Figure A-8 The “Changes Made” dialog box

Although the available options appear in two groups, only one option in the dialog box can be selected. The options are self-explanatory.

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B Technical Appendix – System Flags

nanoLC has predefined system flags that provide status information during project execution. These flags are available through nanoNavigator. The flags that appear in the Data Item Editor depend on the configuration options specified.

B 1 Base Unit Flags

There are eight flags associated with the base unit. They are:

Table B-1 Base Unit Flags

Flag	Name	Description
F-64	Real Time Clock Fault	True if RTC is missing at startup, or missing at one hour check
F-65	Real Time Clock Battery Low	True if RTC is present and battery is low
F-66	Operator Display Fault	True if Operator Panel is not present
F-67	Comm. Expansion Fault	True if Communication Expansion Module is not present
F-68	Serial Modbus RTU Timeout	True if Modbus RTU Timeout Value != 0; and A Modbus RTU Command has been received since startup; and The timeout value was exceeded between Modbus commands
F-69	Reserved 1	Always OFF
F-70	Reserved 2	Always OFF
F-71	nanoLC Stopped	Used by Modbus hosts

B 2 Ethernet Flags

There are 32 flags associated with the Ethernet module. They are:

Table B-2 Ethernet Flags

Flag	Name	Description
F-72	ETH Set Read-Only Mode	Sets all data items to be read-only when accessed through the Ethernet port
F-73	ETH Command 01 (Reserved)	Reserved for future use
F-74	ETH Disable Port	Disables the Ethernet port from remote access from outside network sources
F-75	ETH Request DHCP	Requests the Ethernet module to enter a mode asking for an IP Address from a DHCP server

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Table B-2 Ethernet Flags

Flag	Name	Description
F-76	ETH Request BOOTP	Requests the Ethernet module to enter a mode asking for an IP Address from a BOOTP server
F-77	ETH Enable Web Access	Allows the Ethernet module's web server to be accessed from a network connection
F-78	ETH Reset to Factory Default	Resets the Ethernet module's configuration data to the factory default settings. The IP Address is also reset to 0.0.0.0
F-79	ETH Command 07 (Reserved)	Reserved for future use
F-80	ETH Command 08 (Reserved)	Reserved for future use
F-81	ETH Boot Request	Requests the Ethernet module to stop communicating to the base to allow the base module to enter bootloader mode.
F-82	ETH Reset Request	Requests the Ethernet module reset itself to the stored settings
F-83	ETH Command 11 (Reserved)	Reserved for future use
F-84	ETH Command 12 (Reserved)	Reserved for future use
F-85	ETH Command 13 (Reserved)	Reserved for future use
F-86	ETH Command 14 (Reserved)	Reserved for future use
F-87	ETH Command 15 (Reserved)	Reserved for future use
F-88	ETH Module OK	The Ethernet module is operating properly
F-89	ETH Connection Established	A Modbus/TCP Ethernet connection has been established from a host computer
F-90	ETH Write Data Watchdog	The Watchdog timer has expired without receiving a Write command from any connected Modbus/TCP host computer
F-91	ETH DHCP Failed	The Ethernet module is configured to obtain its address from a DHCP server, but either the assignment failed or a DHCP server is not present on the network
F-92	ETH BOOTP Failed	The Ethernet module is configured to obtain its address from a BOOTP server, but either the assignment failed or a BOOTP server is not present on the network
F-93	ETH IP Conflict	Another device on the network has the same IP address as this Ethernet module
F-94	ETH Status 06 (Reserved)	Reserved for future use
F-95	ETH Status 07 (Reserved)	Reserved for future use
F-96	ETH Status 08 (Reserved)	Reserved for future use
F-97	ETH Status 09 (Reserved)	Reserved for future use
F-98	ETH Status 10 (Reserved)	Reserved for future use

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Table B-2 Ethernet Flags

Flag	Name	Description
F-99	ETH Status 11 (Reserved)	Reserved for future use
F-100	ETH Status 12 (Reserved)	Reserved for future use
F-101	ETH Status 13 (Reserved)	Reserved for future use
F-102	ETH Status 14 (Reserved)	Reserved for future use
F-103	ETH Status 15 (Reserved)	Reserved for future use

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C Technical Appendix – Analog Device Scaling

This appendix describes the scaling formula and shows examples of scaling provided by analog devices on the nanoLC.

Voltage values were read with a Fluke® digital volt meter with voltages applied by a 0 – 10-volt potentiometer. Current values were applied with a regulated DC power supply. Voltage and Current sample settings shown below.

These are sample values. Your values may be slightly different or exactly the same based on the input device type.

C 1 Scaling Formula

Adding scaling to the inputs differs from the “No Scaling Applied” table. Scaling is applied to each input with the default being 0-4095. The base firmware will calculate the new integer values based on the scaling applied.

Variable names:

– ”LowScale” is the value entered as “Scaling Lower Value.” This is the scaled value that equates to the low limit of the range (i.e., reading 0 V for a 0-10 V range).
– “HighScale” is the value entered as “Scaling Upper Value.” This is the scaled value that equates to the high limit of the range (i.e., reading 10 V for a 0-10 V range).
– DataValue = Value read from the analog module - This value is always in the range of 0 to 4095 (0 for low limit of range and 4095 for high limit of range).

With scaling applied, values in analog inputs are the “ScaledDataValue” and not the actual “DataValue”.

To illustrate the formula with an example, assume that “DataValue” with no scaling and a 5 V input provides an “ActualDataValue” of 2048. A “DataValue” with 0 to 1000 scaling and a 5 V input provides a “ScaledDataValue’ of 500.

The formula for the “ScaledDataValue” is:

*ScaledData Value = (((HighScale - LowScale) * DataValue) / 4096) + LowScale*

For example:

If “LowScale” = 0 and “HighScale” = 100 and “DataValue” = 1024 (i.e. reading 2.5 V on a 0-10 V range),

*ScaledDataValue = (((100 - 0) * 1024) / 4096) + 0 = 25*

If “LowScale” = 1000 and HighScale = 10000 and DataValue = 1024 (i.e. reading 2.5 V on a 0-10 V range)

*ScaledDataValue = (((10000 -1000) * 1024) / 4096) + 1000 = 3250*

If “LowScale” = 100 and “HighScale” = 0 and “DataValue” = 1024 (i.e. reading 2.5 V on a 0-10 V range)

*ScaledDataValue = (((0 - 100) * 1024) / 4096) + 100 = 75*

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C 2 No Scaling Applied Example

Table C-1 Default scaling at 0 to 4095

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
0	4 mA = 0	0 V = 0	-10 V = 0
	5 mA = 264	1 V = 412	-8 V = 448
	6 mA = 516	2 V = 824	-6 V = 848
	8 mA = 1022	3 V = 1236	-4 V = 1248
	10 mA = 1530	4 V = 1648	-2 V = 1648
2048	12 mA = 2048	5 V = 2048	0 V = 2048
	14 mA = 2567	6 V = 2476	2 V = 2458
	16 mA = 3073	7 V = 2894	4 V = 2872
	18 mA = 3578	8 V = 3304	6 V = 3284
	19 mA = 3837	9 V = 3714	8 V = 3698
4095	20 mA = 4095	10 V = 4095	10 V = 4095

C 3 Scaling Applied Examples

Table C-2 Scaling set to 70 to 90

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
70	4 mA = 70	0 V = 70	-10 V = 70
	5 mA = 71	1 V = 72	-8 V = 72
	6 mA = 72	2 V = 74	-6 V = 74
	8 mA = 74	3 V = 76	-4 V = 76
	10 mA = 77	4 V = 78	-2 V = 78
80	12 mA = 80	5 V = 80	0 V = 80
	14 mA = 82	6 V = 82	2 V = 82
	16 mA = 84	7 V = 84	4 V = 84
	18 mA = 87	8 V = 86	6 V = 86
	19 mA = 88	9 V = 88	8 V = 88
90	20 mA = 90	10 V = 90	10 V = 90

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Table C-3 Scaling set to 0 to 1000

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
0	4 mA = 0	0 V = 0	-10 V = 0
	5 mA = 64	1 V = 100	-8 V = 100
	6 mA = 125	2 V = 200	-6 V = 200
	8 mA = 249	3 V = 300	-4 V = 300
	10 mA = 374	4 V = 400	-2 V = 400
500	12 mA = 500	5 V = 500	0 V = 500
	14 mA = 626	6 V = 600	2 V = 600
	16 mA = 749	7 V = 700	4 V = 700
	18 mA = 873	8 V = 800	6 V = 800
	19 mA = 937	9 V = 900	8 V = 900
1000	20 mA = 1000	10 V = 1000	10 V = 1000

Table C-4 Scaling set to 0 to 10

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
0	4 mA = 0	0 V = 0	-10 V = 0
	5 mA = 0	1 V = 1	-8 V = 1
	6 mA = 1	2 V = 2	-6 V = 2
	8 mA = 2	3 V = 3	-4 V = 3
	10 mA = 3	4 V = 4	-2 V = 4
5	12 mA = 5	5 V = 5	0 V = 5
	14 mA = 6	6 V = 6	2 V = 6
	16 mA = 7	7 V = 7	3 V = 7
	18 mA = 8	8 V = 8	4 V = 8
	19 mA = 9	9 V = 9	5 V = 9
10	20 mA = 10	10 V = 10	10 V = 10

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Table C-5 Scaling set to 0 to 2000

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
0	4 mA = 0	0 V = 0	-10 V = 0
	5 mA = 128	1 V = 200	-8 V = 200
	6 mA = 252	2 V = 400	-6 V = 400
	8 mA = 499	3 V = 600	-4 V = 600
	10 mA = 748	4 V = 800	-2 V = 800
1000	12 mA = 1000	5 V = 1000	0 V = 1000
	14 mA = 1253	6 V = 1200	2 V = 1200
	16 mA = 1499	7 V = 1400	4 V = 1400
	18 mA = 1747	8 V = 1600	6 V = 1600
	19 mA = 1874	9 V = 1800	8 V = 1800
2000	20 mA = 2000	10 V = 2000	10 V = 2000

Table C-6 Scaling set to 100 to 1000

Device Range/ Integer Value	4 to 20 mA	0 to 10 V	-10 to +10 V
100	4 mA = 100	0 V = 100	-10 V = 100
	5 mA = 158	1 V = 190	-8 V = 190
	6 mA = 213	2 V = 280	-6 V = 280
	8 mA = 324	3 V = 370	-4 V = 370
	10 mA = 436	4 V = 460	-2 V = 460
550	12 mA = 550	5 V = 550	0 V = 550
	14 mA = 664	6 V = 640	2 V = 640
	16 mA = 774	7 V = 730	4 V = 730
	18 mA = 886	8 V = 820	6 V = 820
	19 mA = 943	9 V = 910	8 V = 910
1000	20 mA = 1000	10 V = 1000	10 V = 1000

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